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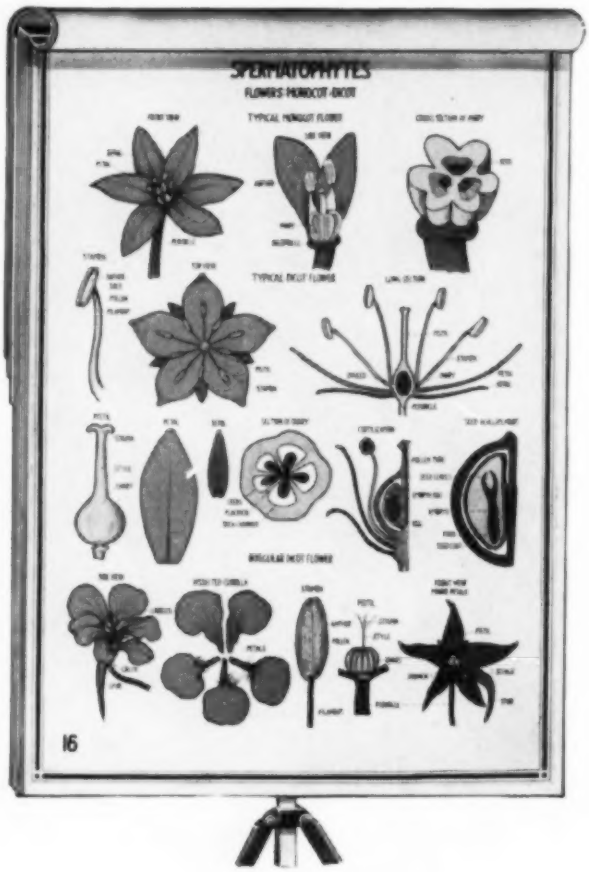

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Concepts and Techniques in Teaching the Organic Chemistry Laboratories

By Arthur Furst, Associate Professor of Medicinal Chemistry, Stanford University School of Medicine, San Francisco, California.

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The Science of Modern Household Laundry Appliances

By Otto Doutlick, Director, Appliance Testing Laboratory, The Whirlpool Corporation, St. Joseph, Michigan.

•

American Democratic Society and the Second Industrial Revolution

By Clarence C. Walton, Dean, School of Business Administration, Duquesne University, Pittsburgh, Pennsylvania.

Health Careers . . .

A Broadening Horizon for Science Students

• By Philip E. Ryan
EXECUTIVE DIRECTOR, NATIONAL HEALTH COUNCIL, NEW YORK CITY

An invaluable aid for vocational advisors and the pupils they advise has just been published.

Here is news about a Guidebook that offers high school pupils a realistic picture of 150 health professions and occupations. Published by the National Health Council, it is being made available free to all the nation's public and private secondary schools.

Science teachers, who are often informal career counselors, should not fail to examine this indispensable aid.

●

No one realizes more clearly than the science high school teacher and the vocational counselor that many of today's careers call for good grounding in the basic sciences. Yet one of the fields where science has made some of its greatest advances has often had too little attention when youth's career opportunities are under discussion.

This is the field of health sciences and health services. But if careers in this area have been to some extent by-passed by science teachers and guidance counselors, it has not been for lack of interest on their part. What has made it difficult, even for these experts, to introduce their students to health careers is the size of the field itself. The very number of opportunities and the variety of scientific skills and aptitudes required have been responsible to a great extent for the lack of centralized information about the field as a whole.

To meet this need—felt by both student and advisor—is the goal of a new *Health Careers Guidebook*, covering more than 150 health professions and occupations. Published by the National Health Council, and supported in the public interest by one of the Council's sustaining members, the Equitable Life Assurance Society of the United States, this is the most comprehensive view of career opportunities in the health field that has ever been presented.

The *Guidebook* offers authoritative, up-to-date information about all kinds of occupations in the health services, written and illustrated in a style designed to attract teen-age interest. Well over half the occupations described require some degree of specific education in science. In addition to the traditional health professions like medicine and dentistry, the explicitly science-oriented careers in health include professional specialties and supporting occupations in biology, chemistry, mathematics, physics, physiology, psychology, and the social sciences. Some of these careers, of course, demand continuing and intensive scientific training, extending to and beyond a graduate degree. But others require less training. Medical technology, for example, has a minimum requirement of two years of college, plus one year of special training. Some supporting jobs require only the kind of training available in most secondary schools—statistical clerks, laboratory secretaries and various kinds of laboratory assistants, for example.

The *Health Careers Guidebook* was formally launched on February 21, 1955, when first copies were presented to officers of the National Association of Secondary-School Principals during their 39th annual convention in Atlantic City. Beginning in mid-March, the *Guidebook* was sent free of charge to all the nation's 29,000 secondary schools, both public and private. It is not necessary to request copies; complete nationwide distribution has been arranged as part of the basic plan.

Perhaps the background story of this *Guidebook*—an account of how it came into being—belongs in any discussion of the book itself. In March, 1954, the National Health Forum, which the Council sponsors each year, met to consider what could be done to apply new knowledge about health effectively in terms of the services actually available to people in their own communities. It was obvious that a major obstacle was the lack of trained people—of the scientists, technologists, physicians and others whose work is vital if the nation is to make the most of its health resources. Records showed that young people were entering the health field in numbers scarcely large enough to maintain present services. Yet almost any informed person realizes today that the calls on such services are increasing—both because of our growing population, and because of our constantly rising standard of living with its emphasis on better health care.

The national organizations which make up the National Health Council—including some 49 major professional societies and health agencies—appointed an advisory committee to recommend a course of positive, long-term action. Out of this cooperative attack, there developed what was soon to be known as Operation Health Career Horizons.

So a nationwide project, designed to tell young people about opportunities in health, was formally launched last June. It was a cooperative venture, right from the start. Agencies and organizations dealing in any way with health gladly contributed material or information, and those directly involved agreed to check the briefings on various jobs as they were written. At the end of each career description, there is a "for further information" reference to the appropriate professional society or similar organization, so that the interested student can obtain additional details about schools, qualifications, aptitude tests and the like.

(Continued on Page 74)

Revolution in the Home Laundry

• **By Frank H. Trembly**
CHAIRMAN, EDUCATIONAL SERVICE COMMITTEE, AMERICAN GAS ASSOCIATION, NEW YORK CITY

Guess work is being eliminated from home laundry procedures. Science and technology have joined to make washday no longer a burden.

Automatic clothes washers and dryers and new ironing devices have led to improvements in water softeners and water heaters. More effective detergents have been developed as well as new textiles and fabrics. Even garment construction has been affected. The chain reaction is still in progress.

What about laundry instruction in the secondary school?

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There's been a revolution—a real revolution—in the American home laundry, a post-war modernization that's lifted the heavy hand of drudgery from the laundering operation and endowed it with an automaticity almost beyond belief. A brand-new freedom has been given the homemaker.

The primary reason for this renaissance is the automatic clothes-washer, and more recently, the automatic clothes-dryer.

Back in 1946, ten years after its appearance on the market, a grand total of 360,000 automatic washers were in use. Today, there are between nine and nine and one-half million. 1954 sales were well over 2 million; 1955 predictions are that two and three-quarters million new automatic washers will be placed in use. And it's further predicted that soon thereafter, 70 per cent of all wired homes will be equipped with this modern machine, a percentage that is reasonably close to practical saturation.

The automatic washer has been a tremendous success, and more than a mere sales success, for in a few short years it has changed the way of life in many millions of homes—and for the better. It has been responsible for the development of *new* home laundry equipment—it has been responsible for the improvement of *old* equipment.

Following the quick public acceptance of the automatic washer, what could be more logical than the invention of the automatic clothes-dryer; for what price progress, if clothes are to be washed automatically only to be dried by the centuries-old clothes-line method? Made in gas and electric models, the automatic dryer is finding an accelerated acceptance in American homes.

The automatic rotary ironer and the combination steam-and-dry hand-iron have been available for a number of years, but post-war developments have made important improvements to these appliances, that also contribute to the complete modernization of the home laundry.

The automatic water heater is certainly not a new appliance, but when manufacturers saw the skyrocketing success of the automatic washer and learned of its more critical hot water requirements—higher temperatures and greater quantity—designers were put to work to meet the demand. Improved models quickly made their appearance, particularly in the field of gas-fired water heaters because the fast heating speed of the fuel and its flexibility made the re-design comparatively simple. Today, two temperatures of hot water are simultaneously supplied by a single water heater, 180° F. hot water piped directly to the automatic clothes-washer and dish-washer, and 125° F. hot water supplied to the bath, lavatory and other general-purpose outlets. These tank water temperatures are higher than those of actual use, but they are necessary to allow for piping and other temperature losses after the hot water leaves the storage tank.

The water softener has likewise joined the home laundry modernization parade. It has been simplified, reduced materially in size and made fully automatic. In many communities, soft water may be had on a monthly service basis, without the necessity of purchasing any equipment at all. Anyone who has washed in hard water quickly realizes the value of softened water, and as a consequence, its popularity is constantly growing in those areas where the water supply has a hardness of approximately six grains or more.

Just as the automatic washer has made home laundry equipment history, so has it been the cause of radical changes in the field of detergents. There are two general classes of detergents, of course, soap, and the new synthetic detergents, which are often called syndets. In a few short post-war years, use of snydets has far outstripped that of soap, and the end is not in sight. Special syndets of the normal sudsing and low sudsing variety have been developed for use in the automatic washer, and more are being sought. Many other new packaged laundry products—water softeners, bleaches, starches and bluings have also been developed.

The home laundry revolution is causing a basic change in textiles. The trend is definitely toward the manufacture of fibers and fabrics that need not be pampered by hand-washing in lukewarm water. White fabrics made of practically every fiber, natural or man-made, can be washed at the temperature of 150-160° F. in the automatic washer, recommended as the optimum temperature by research authorities. Cottons, linens and rayons in most of their colored fabrics have long been very washfast. Some of the man-made fibers, acetate, nylon and others, have, because of color-dyeing difficulties, had wash-temperature limitations, but it is a sign of the times that leading makers are now producing colored fibers and fabrics that can be safely washed at optimum soil-removing temperatures.

Fabric weaves today are firmer to withstand the vigorous washing action of the automatic washer. Even such dry-cleanables as blankets, electric blankets included, can be automatically washed with complete safety. Garment construction has been improved with machine-washing in mind. The garment-making industry has at long last realized that it is highly inconsistent to make a garment with a washable outer fabric and with a lining that must be dry-cleaned.

There has indeed been a great post-war change in the textile field. The reason for it all? Simply this—the homemaker has an automatic washer and wants to do *all* of her washing in it, and since she is the official textile buyer for her family, her word is law. She is the final judge and jury. The result is that more and more washer-washable fabrics and garments are being made and sold.

Garment labeling, long inadequate and misleading, is undergoing a change that will give the buyer simple and exact washing instructions. Leading in this great reform is the National Standards Association and the National Retail Drygoods Association. You have seen or will soon see their new signal color system of labeling rayon and acetate fabrics,

—a **red** label that signals "don't wash this fabric at all: send it to the dry-cleaner,"

—an **amber** label that cautions that the fabric must be washed with care in warm water,

—a **green** label that tells the homemaker that the fabric can be washed in 160° F. hot water in the automatic washer.

This simple system will no doubt be broadened to include all fibers and fabrics, and in the meantime the textile manufacturers are moving steadily toward more informative labeling.

Complete information labels are still rare, but a good label shows:

1. Fabric trade-name, if any.
2. Garment maker's name.
3. Colorfastness to light, crocking, atmosphere (fume fading), perspiration, and especially to washing.
4. Special finishes used.
5. Per cent of residual shrinkage, if it has a shrink-control finish.
6. Special care instructions including washing, drying, ironing, hand or machine-washing, wash-water temperature, use of automatic dryer.

Home laundering procedures themselves, sorting, loading, washing, bleaching, bluing, starching, stain removal, drying, dampening and ironing, folding and storing, to name the ten major steps, are ridding themselves of guesswork formulae as homemakers look for and follow the recommended "recipes" of nationally-recognized home laundering specialists who have proved their methods in home and laboratory.

More special laundering information than ever before is easily within the reach of the homemaker. Feather pillows, eiderdown or feather comforters, quilts and quilted robes, shag or cotton robes, slip covers and draperies are but a few of the special items that can be washed and dried automatically. There are even special "recipes" today for tinting old fabrics in the automatic washer. Stain-removal, long a troublesome task for the homemaker, has been so simplified that it is now a routine and easy task. There are authoritative washing, drying and ironing instructions for the natural fibers, cotton, silk, wool and linen, and for every man-made fiber, rayon, acetate, nylon, dacron, acrilan, dynel, orlon, vicara and glass-fiber.

There is in fact no lack of information on any phase of the home laundering.

Colleges and universities with schools or departments of home economics are expanding home laundering instruction and the use of modern equipment is made easily available by the liberal "school plans" of many manufacturers.

Much has been done and much remains to be done in the secondary schools. In a national sense, there are many home laundering equipment deficiencies that can be quickly remedied by using the many attractive "school plans" offered by manufacturers of automatic washers, dryers, ironers and water heaters.

Text books and other specialized printed matter are at hand in increasing numbers. The manufacturers themselves have much valuable material to offer. The Educational Service Bureau of the American Gas Association has recognized the vital importance of modern home laundering education in secondary schools, by publishing its book **All About Modern Home Laundering* and its accompanying *Teaching Guide.*

Effective and specialized help in most communities is quickly to be had from local utilities. Gas utilities particularly are building up their home laundering services and are always ready to help their schools organize a new program or improve a present program. Many have complete and modern home laundries in full operation in their home service departments and will welcome visits by school groups to receive instruction from competent specialists. Many manufacturers of equipment and detergents maintain home economics departments which are looking for opportunity to serve the secondary schools. Some makers of textile fibers and fabrics are organized to provide speakers and help promote better home laundering in other ways.

Yes, there has indeed been a revolution in the home laundry. Old-time laundry methods, equipment and products are on the way out. The transition has been rapid and it continues at an accelerated pace.

As new methods, equipment and products move into millions and millions of homes, the need for more laundry instruction in our secondary schools becomes increasingly apparent. Whether the school program is a broad one embracing full equipment and complete classroom instruction, or whether home laundering is confined to a single course or even a part of a course, it is without doubt an activity that calls for serious planning and quick action—*now!* ●

* *All About Modern Home Laundering*, an 80-page book prepared with the help of eight nationally-known authorities, covers all phases of the subject. It is published by the Educational Service Bureau of the American Gas Association, 420 Lexington Avenue, New York, N. Y., who will send one free copy to all teachers who now have or who are considering the formation of home laundry classes. With *All About Modern Home Laundering*, and its *Teaching Guide*, home laundering instruction can be quickly gotten under way. For classroom work, the book is sold in quantity at unusually low prices.

Elementary Science is on the Way *Out!*

• **By Emery L. Will**
CHAIRMAN, SCIENCE DEPARTMENT, STATE UNIVERSITY TEACHERS COLLEGE, ONEONTA, NEW YORK

Inspiration and help in generous quantities for the teacher of elementary science.

Is expensive equipment necessary for good science teaching in the lower grades, or are there outdoor resources available to all? Can young pupils be taught to observe and interpret? How would you teach children in the primary grades about birds? Did you ever take a ten-minute science field trip?

"Science is everywhere around us,—and yet it is nowhere until we have learned how to observe and use it."

●

What has happened to the "good old days" in science teaching? The days when a student's only schooltime acquaintance with a frog began and ended with a pickled specimen in a jar of preservative? Or the days when the child who ventured to bring a live animal to school merited only disapproval?

The seeming inflexibility of curriculum schedules, the overwhelming amount of science to be covered, and, all too frequently, the feeling of inadequacy of a teacher in coping with the magnitude of outdoor science were prominent in their effects upon science teaching, especially in the elementary schools. But why deny to our children the tremendous educational values which accompany the thrill of discovery and the excitement of catching the spirit of the changing seasons reflected in the plant and animal life outdoors?

As elementary science programs have taken shape in recent years as integral parts of a complete science program throughout a school system, there has developed a re-evaluation of what belongs where in the science program. Elementary school teachers are recognizing the need for training in the interpretation of their outdoor environment, and in the various means of utilizing this valuable source of science experiences. We have come to realize that elementary science is here to stay and grow, and, further, that some of its best expressions are truly on the way out,—that is, outside the classroom walls.

Science is everywhere around us,—and yet it is nowhere, until we have learned how to observe and use it. How many times have you passed a particular group of trees, seeing naught but their shade and stateliness, until someone pointed out to you their different rates of growth; the animal visitors to the different species; the relative rates of flowering, leafing out and fruiting; their effects upon local air movements and humidity; and the condition of the soil under them? Boys and girls are ready and eager to study these outdoor resources, which make up a surprisingly large portion of their worlds. As a child progresses, his horizons should expand accordingly, and he needs guidance in learning to observe and interpret his surroundings. He needs help in learning to sort out the relevant from the irrelevant, and in acquiring other aspects of scientific thinking. And herein may be found the basis for a sound foundation in science, without the restrictions imposed by expensive equipment and extensive travel.

This emphasis upon observations and interpretation, with all ages of pupils, is facilitated through the regular use of field experiences, which, like other teaching aids, should be employed when they are the most effective means for presenting certain points. Although many of the recent elementary science films are excellent, they cannot replace the direct contact of a child with his environment. Frequently, the environment can be brought closer to the classroom, or even inside the classroom, for more intensive study of its component parts.

Thus, in the primary grades, where children are seeking simple answers to their questions, which usually begin with "what is it?", a series of correlated observations will help them to open their eyes, and to brush away fears of the unknown. In the case of bird study, why not begin with directed observations of the month-by-month activities of two or three familiar birds, rather than conducting an exercise in mass recognition of many species? Once each month, or oftener at times of peak activity, the pupils can record such observations as the bird's outward appearance; time of molting; periods of brightest coloring; migration; current food selections; choice of habitat; problems of survival; and other aspects of its behavior. The thrill of finding a robin's nest will be even greater when the same kind of bird has been recognized at a school feeding station in late winter, or is observed defending his territory against other male robins and taking bits of string or other material from the "super-

THE FINDING of this robin's nest in a blue spruce tree is only part of good training in the observation of bird life.

market" of bird nesting materials set outside by the class. As these experiences accumulate, there begins to take form a picture of animal life. By making their own observations and recordings, the pupils gradually gain an appreciation of systematic study and the meaning of controlled experiments. As they progress further, they begin to see other changes outdoors which correlate closely with changes in the activities of birds. Their concept of the changing seasons takes on a practical meaning, in which certain signs indicate major changes, while others are interpreted as not being significant trends.

Inside the classroom, follow-up studies may be made at different grade levels, and means should be devised for bringing the outdoors closer for regular inspection. Bird feeding stations erected at the classroom windows may bring specimens so close that their feeding habits and adaptations may be closely observed. Through such experiments as varying the food put out, artificially coloring it, altering feeding times, and trying different types of feeding devices, pupils can learn much about each kind of bird. They can learn that birds need "travel lanes" of shrubs or trees if they are to visit an isolated feeding tray. This knowledge may extend itself outside again, as they consider means for attracting wildlife to the school grounds. Arbor Day can take on a real meaning for them, as they formulate plans for types of plant life to be established, where it should be located for most effective use, the soil requirements, and other considerations. As they visit wooded areas on and off the school property, they may ask themselves about the value of leaving dead standing trees for wildlife, and see one answer in the rectangular-shaped hole drilled out by the pileated woodpecker in its quest for the big black carpenter ants tunnelling through the interior of the tree.

Elsewhere in the classroom, the outdoors may be brought in by such aids as the terrarium, antarium, aquarium and cages. The terrarium, in particular, with its glass sides, enables pupils to bring in a small segment of a woodland, an open field, the school lawn, or other habitat, and to study its characteristics at close range. Terraria may also be adapted successfully for use as miniature greenhouses, in which humidity and temperature can easily be controlled for the propagation of plants. In the use of living specimens, elementary science teachers must recognize the limited attention spans of young children, and the need for training them to be observant, humane and responsible. With these points in mind, visitors' cages are designated, and into them go the multitude of creatures which children bring to school. Frequently, the child bringing the animal is assigned to take care of it, and elementary research is initiated to determine its food and living needs, characteristics and behavior. The visitors are kept long enough for the pupils to make good observations and to gain experience in caring for them, following which the animals are returned to their natural habitats.

"WITHIN THESE rectangular holes in what apparently was a healthy white pine are found the clues which explain why the pileated woodpecker drilled them out."

Indoor experiences, however, should only be extensions of direct observations outdoors. Many teachers complain bitterly of the lack of time and outdoor facilities, but, frankly, can that be significant when we recognize that a child's immediate environment is overflowing with science mysteries which need solving and interpreting? Excellent lessons can be taught through the use of simple observations of resources within a stone's throw of the school building. The animal life which visits a familiar autumn or spring flower may be more abundant than you think. How do you know that the insects and birds visiting the flower in early morning are the same ones which come at noon or later in the day? With careful observation, it can usually be determined exactly why the creature visits the flower at particular times,—perhaps to coincide with the emergence of tiny insects upon which it feeds, or perhaps due to the particular habits of the flower itself, or for other reasons. Think of the multitude of simple observational experiences which can become complete science lessons with the barest of resources and the most limited equipment!

One of the most helpful devices in this connection is the development of a series of five-minute and ten-minute science field trips. As an illustration, let us drop in on a fifth grade field lesson which includes elements of biological and physical science, tied together by the thread of natural resource conservation. In the upper elementary grades, by building upon previously acquired observations, a teacher can do much to show the interrelationships existing among plants, animals and their environment. The setting is a familiar one,—a wooded slope, with last autumn's leaves carpeting the ground. As we first look at this spot, we see only the well preserved leaves of white oak and beech, with their lifeless brown color and brittleness. What has happened to the bright green color and soft texture of the leaves as we remember them last summer?

The lesson could break off there with the whole story of food production and autumn coloration,—but let's look again at the leaf carpet. Underneath the oak and beech leaves, we have difficulty in recognizing the outline of the sugar maple leaves, partly eaten by insects and bacteria. Someone asks which leaves fell first last autumn, and the sequence is spread out at our

(Continued on Page 78)

Understandings in Elementary Mathematics

• By **Joseph Seidlin, Ph.D.,** *(Columbia University)*
DEAN, THE GRADUATE SCHOOL, ALFRED UNIVERSITY, ALFRED, NEW YORK

This delightful paper is an expanded introduction to a recent conference of teachers of mathematics at the elementary and secondary levels over which Dr. Seidlin presided. That his preliminary remarks stimulated questions, answers, and comment that overran the program time goes without saying. Your thinking will be stimulated, too.

●

One of the most difficult concepts to understand is "understanding" itself. It is not merely a matter of semantics. Just as the physician is baffled by the common cold because there seems to be an infinite variety of "cold" viruses, so it might well be that much of our confusion and uncertainty about understanding is due to the fact that there is an infinite variety of understandings, both in kind and in degree. The mathematical physicist who derives a formula; the engineer who computes by means of the physicist's formula; and the technologist, who operates a machine in accordance with the engineer's computation—each, at his best, *understands* what he is doing. The junior high school instructor who teaches his pupil how to solve for x in $x - p = q$ by "transposition"; and the pupil who can solve for x in $x - p = q$ faster than you can say "an unknown quantity"—each *understands* what he is doing.

A substitute instructor who explained to a class how litmus paper is affected by (1) an acid, (2) a base, and then received a unanimously affirmative answer to the question, "Does everybody understand it?", whispered to himself, "That's good; I wish I did!"

Mathematics, even the most elementary mathematics, is essentially an abstract subject. (That is why some scientists accept mathematics as the handmaiden to science, or even as the queen of sciences, but not *as* a science.) That's why we are so confused in teaching it. In order that children (or other immature people) may *understand* mathematics, we teach them how to count (marbles), how to add (apples), how to multiply (columns by rows), how to divide (a pie). Apples and pears get quite a workout. So much so that when these children get to algebra the teacher must actually issue a warning, a sort of commandment, "you cannot add apples to pears." Which is silly, since the girls in the class often add apples to pears in the preparation of a fruit salad.

Periodically we attempt to wean the children from the "concrete" illustrations of abstract processes or principles to the processes or principles themselves. Naturally that isn't easy. All too often we become discouraged and reduce our teaching to mere coaching for tests and examinations. Then everybody begins to blame everybody else for not teaching mathematics (even arithmetic) *meaningfully*. "The children (even college students) can perform quite well—except when they succumb to apathy and carelessness—all sorts of quantitative tricks but they don't seem to *understand* what they are doing." Perhaps this is as good a place as any to say that there is nothing new about this woeful lack of understanding among the pupils or the universal complaining about it among the adults. Progressive or modern theories of Education have not brought it about. Whether they have aggravated the situation or ameliorated it is still an unsettled issue.

Assuming that in general, as in many special cases, mathematics can be taught meaningfully, what advice can we hope to get from those teachers who have been most successful in teaching pupils to understand their mathematical learnings? The following is a not-too-exhaustive list gleaned from the writings and the experiences of teachers of mathematics.

1. Teachers must compromise "absolute rigor" in mathematics. In a very important sense, "Rigor is a function of the rigoree." When a teacher tells a third or fourth grader that 3 minus 5 "can't be done," there are many better ways to help the child understand why "it can't be done" than for the teacher to proclaim solemnly that "In the domain of positive integers some results of inverse processes are inadmissible"!!

2. When understanding forms an essential part of learning, by-passing understanding will not produce the desired learning. Even teachers of psychology, who certainly should know better, have been known to tell their students that they will learn to understand a definition by first memorizing it. A very popular textbook in algebra introduces multiplication of signed numbers as follows: "The best way to *understand* the Laws of Multiplication of Signs is to *memorize* the following four rules"!! Many a student is lost to mathematics, and vice versa, when for the first time in demonstrative geometry he reproduces a proof of a theorem by sheer memorization. Many a textbook, and some teachers, shut out the pupils from ever solving a problem by training them to memorize schemes or techniques guaranteed to work exercises by analogy or imitation. Most of us are familiar with the rectangular boxes provided for the solution of time-rate-distance, mixture, etc., problems. By following directions, however blindly, and by turning the manipulative crank, a correct answer is forced to ooze out into the only empty little rectangle.

3. Rarely is there need to invoke the aid of "higher mathematics" to help a pupil's understanding of an elementary principle or process. More often than not such a practice will discourage or confuse the pupil, and occasionally, it may lead to a common pupil comment: "The teacher knows his stuff but he can't put it across."

When young teacher "A" complained to teacher "B" that he still can't convince his pupils in algebra that

(Continued on Page 76)

Preserving National Documents

• By John L. Kent
CHIEF, EDITORIAL BUREAU, CONSOLIDATED ENGINEERING CORPORATION, PASADENA, CALIFORNIA

A writer of science and industry stories like Mr. Kent considers himself fortunate if he is within reaching distance of the National Archives. Such a writer will rely heavily upon them for historical background and research.

A Washington correspondent for some ten years, Mr. Kent has intimate knowledge of how Uncle Sam preserves his important historical records.

You will be interested in the out-of-the-ordinary story he tells.

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More than ten years before the atomic age, the Government built an impregnable "strong box" in Washington, D. C. in which are preserved for posterity the Nation's historical documents. This strong box is the National Archives Building. The repository is so well built that experts believe it would withstand any atomic or hydrogen bomb attack upon the Nation's capital.

The guardian of this strong box is the National Archives and Records Service, a part of the General Services Administration, the Government's "housekeeping" agency.

A trained staff under the direction of the Archivist of the United States, Wayne C. Grover, goes through all government records periodically and selects those of historical importance.

Most of the records in the Archives are dated from 1789 to 1939. But there are many recent records as well, including thousands of important papers from World War II. The German and Japanese surrender documents are there, too. In addition to papers, there are hundreds of thousands of maps, more than 50,000 reels of motion picture film, and over half a million sound recordings.

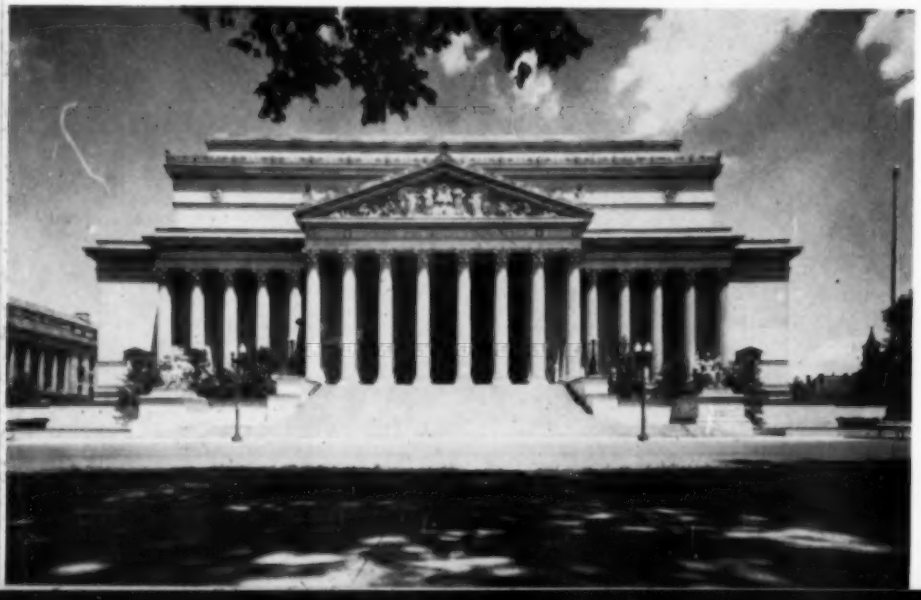
TO KILL BUGS AND GERMS, the records are fumigated in this steel tank.

A major task of the National Archives is to arrange the records received from Federal agencies in proper relationship to each other and in accordance with accepted archival principles. In its initial years, the National Archives was concerned with bringing into its custody the large volume of records that had accumulated in the Federal Government since its establishment. In the decade beginning with fiscal year 1940 an average of 78,000 cubic feet of records were received each year.

A most dramatic and significant transfer of documents was completed on December 13, 1952, when the Declaration of Independence and the Constitution of the United States were formally transferred from the Library of Congress to the National Archives. The transfer, which carried out the purpose expressed by President Hoover when he laid the cornerstone of the National Archives Building in 1933, was made at the direction of the Joint Congressional Committee on the Library and with the cooperation of the Librarian of Congress.

With the acquisition of these documents and the main body of the papers of the Continental Congress from the Library of Congress, virtually all the valuable older papers of the executive departments and agencies, the Congress, and many of the Federal courts are now in the National Archives.

THE NATIONAL ARCHIVES BUILDING IN WASHINGTON, D. C.

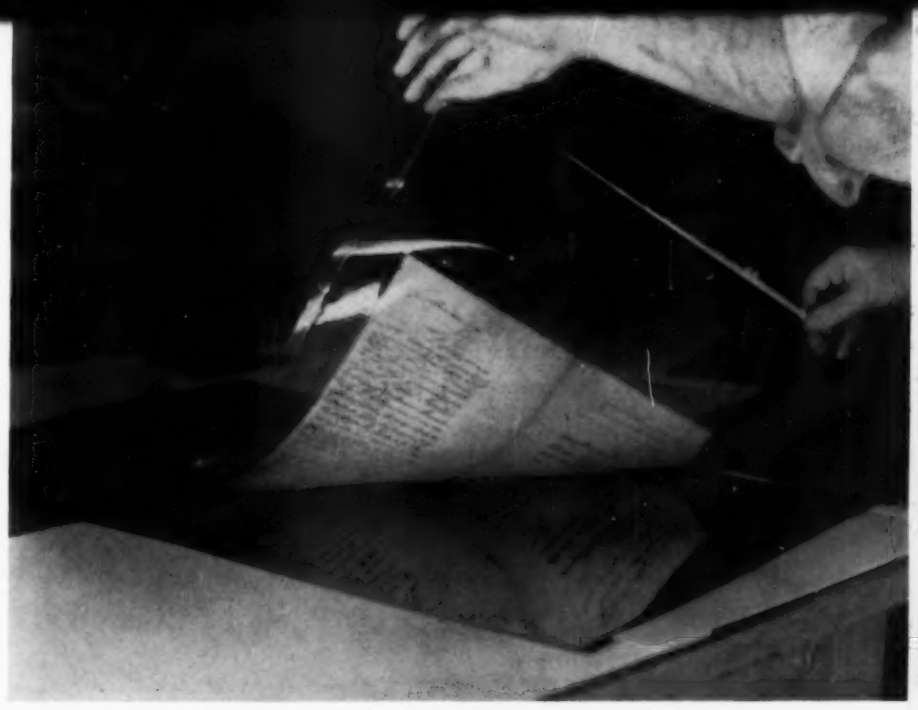


The records in the National Archives are probably used more than the archives of any other central government in the world.

Research workers in the social sciences, for example, recognize the value of archives, and each year bring scholars and graduate students to the Archives Building in increasing number. Last year, for example, a French historian surveyed data on the history of France, 1814-30; a British political scientist obtained information on the regulation of the food and drug industry in the United States; and an author gathered extensive material for a book on the Confederate Congress.

About half of the Archives' staff is engaged in reference service—locating information and making it available.

Requests for reference services arise mostly from the needs of Government officials, industry, and private individuals confronted with important problems. Government requests usually stem from official considerations of national policy, agency operating programs, and administrative problems. In considering statehood for Alaska and Hawaii, for example, Members of Congress studied records of procedures followed in the admission of States to the Union.



THE DOCUMENT which has been protected by clear plastic sheets as it comes from the press. The surplus cellophane-like material around the edges will be trimmed off.

MANY MOTION pictures come under the heading of historical documents. Acetate or safety film is stored on open steel shelves in individual cans.

At no time since the establishment of the National Archives in 1935 has it been possible to reduce substantially the backlog of repair and rehabilitation work on the records that require such attention. The rate at which records were transferred during World War II and the immediate postwar years complicated the development of a preservation program. Repairs to documents and bound volumes have been made only when there was an urgent reference need for them or when they could not be handled without danger of permanent damage. A recent survey revealed that over 8 million items were in critical need of repair and that an additional 11 million items should be repaired within the next few years.

Records brought into the Archives building are first thoroughly fumigated in their original shipping containers to kill insects and mold. Two steel vacuum tanks are used. Each has a capacity of 270 cubic feet of records.

The records are wheeled into a tank, the door closed, and air pumped out. A small amount of ethylene oxide-carbon dioxide fumigant mixture is released into the tank. Three hours later the gas is pumped out, air readmitted, and the records wheeled out.

Most of the records are on paper. Often they're very dusty, and brittle. One man at the Archives does nothing but blow the dust off the stacks of papers brought in. Compressed air is used. The dust is pulled away from the working table by big suction fans.

Many of the papers are creased and have to be straightened out. These are dampened slightly and then pressed on a household mangle, or when extreme care must be used, with an ordinary electric iron.

Archives specialists found that the best method of preservation is to apply a thin, protective plastic cover, using cellulose acetate sheets or foils. These foils soften under heat and are forced into fibers of the

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An Industry-Education Experiment in Film Strip Design for High School Teaching

• By **James Laurits, *and***
ASSISTANT PRINCIPAL, NEWTON HIGH SCHOOL, NEWTON, MASSACHUSETTS

Simon Williams
DIRECTOR OF RESEARCH AND EDUCATION, DUDLEY-ANDERSON-YUTZY, PUBLIC RELATIONS COUNSEL TO THE ALUMINUM ASSOCIATION, NEW YORK CITY

Do science teachers use sponsored teaching aids to their full advantage? Do the devices create favorable attitudes in students? Do they suggest desirable career opportunities? Do they contain too much propaganda? Is industry getting its money's worth for the millions of dollars it spends annually for instructional aids?

Here is an account of a pioneering cooperative study that may very likely cause a change in the thinking of educators and industrialists and bring about a better understanding between industry and education. It doesn't provide all the answers, but it points a way.

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In today's world, where communication facilities are many and marvelous, one might imagine that every boy and girl would have access to all varieties of supplementary materials and that such aids to the classroom would change each year or each month or each week to keep in step at the high school level with the vast, ever-expanding frontier of knowledge in the adult sphere. Surely, excellent opportunities and materials are created daily as our world is viewed, described and reported.

Yet industry and education face this situation:

Industry spends millions of dollars every year in the production of teaching aids. A flood of films, filmstrips, manuals, and booklets now beats on most high schools. The majority of these items are very attractive; some are very expensive to produce; many contain much valuable information.

The various motives behind this effort are clear—to present evidence on how business sees its contributions to our national welfare; to create favorable attitudes toward industry and toward certain products; to attract youth to consider careers in particular enterprises; to help teachers by providing information and materials not otherwise obtainable for the classroom.

However, much of what reaches the school sees relatively little use, or, at least, little effective use.

On the other hand, teachers of science certainly need help in keeping abreast of advances in research and technology, in enriching course content, and in attracting students to courses, let alone careers, in science. Much teaching in American high schools is still confined to one textbook per subject. Many of these textbooks are poorly organized for purposes of learning, and many are out of date. Taken alone, they can be as dull as dust.

Why does this situation exist?

The answer must lie largely in the nature of the teacher's task and in the load he carries. A high school teacher has at least 150 pupils a day. The I.Q.'s of these boys and girls may vary from 70 to 140. Their motivations for school work will range from aggressively negative to highly positive. Each of the teacher's five classes may demand separate preparation, and one must add to this general picture some extra-curricular duties and a heavy clerical load. "Textbook teaching" enables the average high school teacher to survive under the conditions of employment offered to him by the public. It is only those teachers with unusual competence and energy who employ materials and methods above and beyond "Chapter II and the first four questions at the end." It is probable that the teaching aids produced by outside organizations afford little help to the teacher because these aids tend to emphasize *the needs of the sponsor.*

In recognition of this situation, in the Spring of 1954 the Aluminum Association agreed to finance an experiment in industry-education cooperation aimed at finding a method to insure effective use of sponsored teaching aids which would still retain the public relations story and message of the sponsor.

Basic to the experiment were several hypotheses:

1. That a teaching aid becomes increasingly useful and more easily used as the aid supplements and illustrates the *subject matter already chosen by the teacher for inclusion in a course.* In such instances, the learning situation is enhanced, the teacher is not asked to add anything new and time consuming, nor must any course content be dropped in order to utilize the aid.

Therefore, fundamental to the project was agreement that the primary target was the lesson the teacher was already trying to get across and that any information or illustration of aluminum products and processes would be used only if they uniquely demonstrated the principles of the lesson. Consensus was that if a lesson is well learned, the symbols effecting the learning will also be long remembered. If so, an aid to learning could serve both the needs of the teacher and those of the industrial sponsor.

2. That teachers themselves could design aids for industrial sponsors which would best take into

account the needs of the classroom, the requisites of good educational material, and the motives of the sponsor. More than this, the assumption was made that only classroom teachers could do an acceptable job—acceptable to themselves and to their colleagues across the country.

On these bases, the project was initiated in cooperation with the Newton High School, Newton, Massachusetts.

Film strips were selected as the tool. It was thought that visual presentation provided optimum assistance to the teacher. But charts and photographs, presented alone, seemed too static. Movies not only cost a great deal to produce, but their use presents problems of a purely mechanical nature, e.g., the booking of films, the sharing of limited equipment, the necessity for skilled operators, the need to darken rooms, the inability to stop-and-discuss at moments of peak interest. The use of film strips seemed to eliminate most of these difficulties and the overwhelming support for film strips developing throughout the secondary school system supported the choice.

In order to carry out the experiment, there was established an in-service training course which would carry credits toward the salary schedule of the teachers. In addition, the Aluminum Association paid an honorarium to each teacher selected for the course. It was planned to work for one academic year and to have the film strips ready for distribution in the year 1955-56[1]. Two groups of teachers were formed. In one group were three teachers of science; the other group was made up of two teachers from social studies and one from the business department. The activities of both groups were coordinated by the assistant principal.

The first task was to have the group members acquire some background in the aluminum industry. At an organization meeting in the Spring, several publications and reports from the industry were supplied to the teachers, to be studied during the summer recess. One week before school started in the Fall, the group convened and was taken on a five-state tour of aluminum plants and research laboratories. This initial phase of the program proved extremely important. Not only did the teachers acquire many film strip ideas, but they met many executives in the industry and discovered the varying points of view and philosophies represented in the different companies, both helpful in building confidence and understanding during the following months of struggle with the actual design of the strips.

It was not easy to decide on subject matter for each film strip. In beginning its work, the science group surveyed the textbooks for units common to most high schools, which at the same time offered possibilities for illustration with aluminum symbols. In physics, units on machines, Hooke's Law, transference of heat, electricity, and X-rays were considered. In chemistry, the subjects of metals, oxidation and corrosion, the alloy age, ionization, valence, dyes, and abrasives were seriously evaluated. In general science, other subjects such as conservation, water, resources of the sea, and soil were reviewed.

The final choice of the science teachers was to build a family of related strips around a basic chemistry unit, "non-ferrous metals," and to aim its use at Grades 11 and 12 in college preparatory curricula[2]. Since aluminum is the most abundant of all non-ferrous metals and one very close to the lives of the pupils, the subject also lent itself to illustration with aluminum products and processes. This subject bridges chemistry and physics. It was decided to make the first strip an introductory review of the properties of non-ferrous metals, from which other strips could later be developed to give more detail on the individual properties and their implications.

The introductory film strip will be in color, to vivify differences between the non-ferrous metals and their compounds. It was also decided that the use of the film strip should require little or no preparation by the teacher—that its use should not require study of a manual or the reading aloud of text during presentation. This decision was not meant either to eliminate preparation and distribution of a manual or to depreciate the value of a manual (teacher's guide). Rather, to keep the objectives of the project clearly in view, it was necessary, even mandatory, to keep the work load on the teacher at a minimum, as long as this could be done without sacrificing the quality or usefulness of the aid.

Finally, the science teachers chose to add meaning to the conventional presentation of non-ferrous metals by referring throughout the strip to the properties the metals have in common, how these properties compare among the more important metals, and the implications of the comparisons for utilization. The usual textbook development considers one metal at a time.

Most of the film strip concerns itself with the properties of non-ferrous metals, e.g., melting point, malleability, ductility, thermal conductivity, electrical conductivity, tensile strength, resistance to corrosion, lustre, and the formation of compounds. The first few frames present some highlights from the early history of mankind and describe the roles played by different metals. It was, of course, the chemistry of metals which determined their time of discovery and the uses to which they were put.

Each of the nine properties of non-ferrous metals is first conceptualized by a cartoon, all nine cartoons being strung together by means of a common character who, in Disney-like manner, portrays the essence of the property under observation. This technique was chosen for several reasons—to isolate and emphasize the properties per se, to capture interest, to maintain interest, to keep the strip from getting "heavy," among others. The significance of the property is usually related to a process or product involving aluminum, thus giving the

(Continued on Page 79)

[1] The strips will be produced and distributed free of charge by Audio-Visual School Service, New York City. Announcements of availability will be made in the education press when the first strips are completed.

[2] After discussion, it was felt unwise to make film strips for general applicability in college preparatory and terminal curricula. The decision to concentrate on college preparatory pupils was made coincident with the recommendation to the Aluminum Association that a separate series be designed for general science and trade (shop) courses common in terminal programs.

Freedom of Research in the Physical Sciences

• By Jean Ladrière
THE UNIVERSITY OF LOUVAIN, LOUVAIN, BELGIUM

A portion of a paper presented by the writer as a part of the academic contribution of the University of Louvain to the bicentennial celebration of the founding of Columbia University. It emphasizes the fact that Catholics engaged in scientific work have great freedom of research. Theology and the physical sciences are not in conflict.

Professor Ladrière's paper, as well as six papers by other members of the Louvain faculty, appear in TRUTH AND FREEDOM, *No. 5 of the* DUQUESNE PHILOSOPHICAL SERIES, *published by the Duquesne University Press, and copyrighted, 1954, by Duquesne University.*

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Independence of the Physical Sciences from Theology

In the totality of human knowledge theology occupies a very special place. The reason is that theological attempts of explanation are not directed towards the world which is given in our naive experience, but rather towards a reality which has become accessible to us only by means of a Revelation. This Revelation is within our reach only through the written text of a book which, for the believer, is directly inspired by God and therefore represents His word, and through the tradition of a religious society which, for the believer, was instituted by God and presents itself as the guardian of His word. Of course, this Revelation is intelligible, for otherwise it would not be a revelation, i.e. a manifestation or unveiling. It is in human experiences that this Revelation reaches man. The reality of which it gives evidence is reached both in words, expressed in human language, which convey the world of God, and in the religious experience of the community which "lives" God's word.

Theology is a methodical effort of man's reason which applies itself with all the resources at its disposal, including those supplied by philosophy, to the interpretation of the data of this Revelation. It is in this Revelation that theology finds, at the same time, its foundations and its limits. Its *foundation*, because the whole work of theology consists in faithfulness to the data of Revelation. Not even for a single instance can theology deviate from the requirement of a rigorous conformity with the revealed data, under penalty of forsaking its mission. The same can be asserted of positive science with respect to experimentation—positive science would renege its own mission, its fundamental attitude, if it ceased to conform with the data supplied by experimentation. Theology finds its *limits* also in the interpretation of the data of Revelation. These data surpass the capacities of reason (for otherwise they could be recovered in their entirety by reason and would lose their proper character) and we cannot, under the pretext of a better understanding, attempt to reduce these data to the categories of reason.

The criteria of interpretation which theology can utilize must be furnished to it by the datum itself of its studies, and this implies that theology is constantly regulated and circumscribed by the mystery of this datum.

Relying in this way upon the datum of Revelation, the theological attitude finds its meaning only in the attitude of Faith, for it is only for Faith that the revealed datum is given as such, i.e. is recognized as the word of God, and at the same time assumes a meaning. Faith is not a purely subjective movement of adhesion, but a light, an enlightening principle, and this light is the principle of the adhesion implied by Faith. Faith penetrates into the reality to which it adheres and adheres to this reality because this reality permits itself to be penetrated by Faith. More precisely, it is this reality itself that gives man the power to penetrate into it.

Consequently, the experience of Faith is radically different from both the philosophical and the scientific attitudes and does not put forward a claim to substitute itself for them. Undoubtedly, theology, which, as it were, systematically renders this experience of Faith explicit on the level of discourse, will be induced to project its light upon the totality of human experiences and the reality which is open to man's experience. In particular, theology, will have to let its light shine upon the realm of reality in which the physical sciences are interested. Yet, in doing so, theology remains in its own order. It neither offers these sciences a new system of evidences nor imposes upon them a regulating principle to which they would have to submit.

No Contradiction Between Theology and the Physical Sciences

Theology respects reason highly enough to consider it capable of pursuing very far, by virtue of its own power, the elucidation of the laws of nature. Theology is convinced that a properly directed science cannot come into contradiction with its own affirmations. Besides, theology admits as a fundamental principle the affirmation of coherence—whether there be question of the invisible reality, Salvation, which is the object of theology, or of the visible reality which is the object of our immediate experience, or again of the reality of man and in particular that of man's reason. This principle implies that these three orders must of necessity be in harmony because one and the same creative Spirit is the sole principle of all reality. Man is made to know the truth, whether it be truth which is di-

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The Integration of Science Learnings Through the Regional Study Tour

• **By Robert K. Wickware**
PROFESSOR OF EDUCATION, WILLIMANTIC STATE TEACHERS COLLEGE, WILLIMANTIC, CONNECTICUT

Increasingly there is awareness that . . . "the impact of science and technology upon the world may well be determined by the intelligence which can be brought to bear in sensing its interrelationships with the land, the resources, and the people."

Schools have a responsibility to see that science shall not remain compartmented. They must provide broad information on many problems, and they must also teach students how to integrate and interpret data from several fields.

Read here how one school has attacked the problem with gratifying success.

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One of the developing problems in science teaching in the latter half of the twentieth century will be the need to bridge the gap between the narrowly specialized knowledge of the various disciplines of science, and the broad applications of this knowledge from many fields to the explanation of certain phenomena which now as never before lend themselves to analysis and clarification. Explanations of many phenomena formerly could be limited to the data from one discipline. Now, with the increasing fund of knowledge in each of the disciplines, it becomes evident that many cross-inferences need to be drawn in order to develop a real sense of satisfaction and respect for the explanation. These phenomena, which now can be and are being analyzed, are not limited to those of the research laboratory alone.

An explanation of the phenomena of everyday life *now* demands an integration of data from many fields. Photosynthesis might be cited as an example. A modern explanation or analysis of this most basic life process demands in part data on sugars and their synthesization from chemistry, on cell structure and functioning from biology, on light energy and its effect from physics, on growth relationships to light intensities from ecology, and data on modern industrial syntheses from the field of chemical engineering. Or the impact of atomic energy information on the average individual is such that he needs to draw from his knowledge in almost all of the disciplines, usually more than he has studied, even though he be a college or university graduate.

If it is well for the individual to be intelligently aware of some of these multitudinous data and furthermore be able to fuse or integrate these data to produce satisfying explanations, then schools face a task of major proportion. Not only is the problem one of providing broad data on problems, but it is one of developing situations in which students are forced to draw from the various data in order to satisfy their sense of completeness in understanding the situation.

Schools have attacked the problem in many ways. The regional study tour is one method of providing a situation where students are faced with a series of problem situations which demand for any realistic understanding a breadth of data and some organization of these on an integrative plane.

Regional Study Tours, as they were titled by a group of students planning for the first one, grew out of a demand by students, seconded by faculty members, to see at first hand the practical way in which a group of people in a given environment with certain natural resources and a definite historical and cultural heritage developed their patterns of living. Much emphasis throughout the year had been given to the social implications of certain scientific data. Data from the ecology of plants and animals, from genetics, from the use of energy resources and many other aspects of science had been studied. Each seemed to have specific implications for the lives of people and the technological and scientific developments in a community and region. (It must be said here that the first regional study tour grew out of an experimental program at the college in which science, social science and psychology were studied jointly in a seminar on contemporary problems. In succeeding years the study tours have continued, but with slightly different course backgrounds.)

Various regions or sub-regions have been studied. The first tour covered a route from Connecticut through the iron and steel production areas of Pennsylvania, sections of Ohio, Kentucky, Tennessee and the Carolinas, with the T.V.A. area as a high point. Succeeding groups have studied and toured through the Great Lakes area, southeastern Canada, Pennsylvania, as well as repeat tours through some of the sections listed for the original one.

Fundamental to the purpose of the tour has been the orientation study for each area. Students and faculty together have developed a basic outline. Materials have then been prepared by students through research in the library, consulting with resource people, and other means of gathering data. One such outline for the first tour of the southern area follows. It remains typical of some succeeding orientation outlines. Each of the topics as listed was expanded through the students' research and faculty help to include a wide variety of information.

Basic Outline for the Orientation to the Regional Study Tour

1. **The Natural Resources of the Region**
   - 1.1 Geography of the area (rivers, lakes, mountains and general topography)
   - 1.2 Mineral resources (mines, soil types, water resources, etc.)
   - 1.3 Plant life (native and cultivated)
   - 1.4 Recreational resources (parks, etc.)
   - 1.5 Animal life (wild and domesticated)
   - 1.6 Climate, rainfall and temperature
2. **The People of the Region**
   - 2.1 Historical background
   - 2.2 Cultural and sociological groups
   - 2.3 Relationships between the cultural patterns and the area
3. **The Interaction of the People and the Environment to Produce**
   - 3.1 Agriculture
     - 3.11 Types
     - 3.12 Products
     - 3.13 Methods of production
     - 3.14 Markets
   - 3.2 Industries
     - 3.21 Mining, lumbering, etc.
     - 3.22 Processing (metals, wood, cotton, glass, pottery, etc.)
     - 3.23 Distribution
     - 3.24 Power Production
     - 3.25 Others
   - 3.3 Cities, towns and rural communities
   - 3.4 Certain art and music forms
   - 3.5 Group activities (cooperative organizations, religious groupings, etc.)
4. **Certain Problem Areas Emerge in the Interaction of People and their Environment**
   - 4.1 Inter-group tensions
     - 4.11 Extent
     - 4.12 Laws and regulations
     - 4.13 Effect
   - 4.2 Conservation
     - 4.21 Soil
     - 4.22 Water and flood control
     - 4.23 Exploitation of mineral resources
     - 4.24 Forests
     - 4.25 Wild life
     - 4.26 Human exploitation
   - 4.3 City planning
     - 4.31 Housing
     - 4.32 Recreation
     - 4.33 Zoning
     - 4.34 Parks, historical sites, etc.
   - 4.4 Labor and industrial relations
   - 4.5 Education
   - 4.6 Delinquency and crime
   - 4.7 Development of new resources

Data from geology were used especially in understanding the topography, soil and mineral resources, underground caves, hydroelectric power resources. Data from ecology helped to build understanding of plant and animal relationships, human ecological relationships in rural and urban areas, climate in relation to latitude and elevation. Information from biology was used in understanding the classification of the flora and fauna of the various areas, in assessing the possibilities of new plant and animal types to meet the requirements of a developing economy, and in developing scientific background pertinent to discussions of segregation and related problems. Chemistry furnished necessary data for interpreting the chemurgical research of George Washington Carver, iron and steel industrial processes, the phosphate industry of the T.V.A. area, as well as information on soil depletion and resulting plant and animal deficiencies. Hydroelectric power, the construction of the T.V.A. dams and the automation of a steel plant in Pittsburgh drew heavily upon the resources of physics.

Other scientific data were necessarily involved in this orientation study. However, it is important to note that almost all of the information was studied and reported on to the class with little real sensitivity as to its integrative aspect. Each topic in the eyes of the students tended to stand somewhat alone. Though attempts were made to minimize this, any resulting sense of integration was on a textbook or lecture level and not a real part of the thinking and *experience* of students.

Once the tour was actually under way quite a different point-of-view on the interrelatedness of the data they had studied was evident. One of the first roadside "stretch" stops of the bus gave rise to a discussion of the rock and coal strata in the cut at the side of the road, the resulting residual soil and the observed plant life of the area. Many interrelationships became evident. The strength of this initial discussion was reflected three years later in its mention in the senior yearbook. Why other discussions of somewhat similar situations did not produce this vivid lasting impression is one of the persistent and elusive problems of my own science teaching. As the tour proceeded it was obvious that four basic types of integration of ideas were evident, none of which are mutually exclusive of the others.

The first was within the structure of science—a combining or fusion of ideas from the various fields of science. The discussion of the implications of atomic energy at the Oak Ridge Atomic Energy Museum is one example. The coal mine at Scranton immediately gave rise to a discussion on the geological period and the related living things of that period as evident in the fossils showing in the coal seam. The comparison of anthracite and bituminous coal led into consideration of BTU's as well as the geological forces which produce the pressure necessary to metamorphose coal. Other examples of this type of integration could be cited from this specific visit and others.

A second type of integration involved the relationships of the scientific data with the social needs of the individual and society. The visit to one of the demonstration farms in the T.V.A. area exemplified the close relationship between soil erosion and family income, fertilizer application and the availability to mine and refine it, year-round "ensilage fields" and the research on plant life adapted to the climate and fodder needs of animals, as well as scientific farming and the type of on-the-spot research developed as a pattern in the beginning T.V.A. experiment. Multipurpose dams again raised the issue of scientific planning and the needs of people from economic, aesthetic and recreational points

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Science *Versus* Crime

• **By Lauren J. Goin, M.Cr.,** *(University of California)*
DIRECTOR, PITTSBURGH AND ALLEGHENY COUNTY CRIME LABORATORY, PITTSBURGH, PENNSYLVANIA

Once, the policeman obtained his information concerning crimes largely from persons—but too often there were no witnesses or victims to testify. Now science makes "things" give up their secrets to prove either guilt or innocence.

Here is a look behind the scenes in a successful crime detection laboratory.

Mr. Goin has recently been appointed to a position with the Foreign Operations Administration to establish at Djakarta the first police crime laboratory for the Republic of Indonesia.

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In the past half century our civilization has acquired many things which seem commonplace today. Radio, television, automobiles, telephones, airplanes, and many other technical developments increase the complexity of our society. Criminals, the people who act against society by violating laws based on society's customs, modes, regulations, and laws, are quick to utilize technological advances in the commission of their crimes. In order to combat this criminality effectively, the police must also avail themselves of every technical facility to which they have recourse.

Soon after automobiles became a common sight on our streets and highways, the policeman began using them in his work. Radio, telephone, and even television have been adapted by the police to protect better the lives and property of the citizens. In order to keep pace with scientific progress, the police now turn to scientists for assistance in their investigations.

THE COMPARISON microscope is used to compare a bullet from the questioned gun with the fatal bullet.

The Spectrograph in operation.

Scientific crime detection is a relatively new aspect of criminal investigation. The first crime laboratory in this country was established in 1930 at Northwestern University. Since that time, numerous crime laboratories have been established on the city, county, state, and Federal levels, the largest being the Federal Bureau of Investigation laboratory at Washington, D. C. The sole purpose of these laboratories is to assist police by determining what information can be obtained by the scientific study of the things, or "physical evidence," recovered in the investigation of crime.

Consider for a moment the root of the policeman's problem when he begins to investigate a crime. He must obtain *information.* Before 1930, he had one principal source of information and that was *from people* . . . What did the victim see, hear or smell? What did witnesses see or hear? What did the suspect say? Using such facts the policeman did the best that he could. With the crime laboratory added to his bag of tools, the policeman now has another source of information available, information *from things.* The value of this type of information can be realized when one considers that in most crimes (murders, burglaries, larcenies, hit and run, etc.) there are no witnesses or victims to give information of value.

Since it is the function of the crime laboratory to determine as accurately as possible what information is available from an examination of the evidence, it is frequently found that this information points toward the guilt of a suspect. A less known and just as important fact is that the information developed oftentimes proves innocence as well. In this way the possibility of a miscarriage of justice is materially re-

THE LIE-DETECTOR in action. (A posed photograph.)

duced and investigating time on the part of the police is saved.

To see how science aids the policemen, let's take a close look at the Pittsburgh and Allegheny County Crime Laboratory. A completely autonomous organization situated in the District Attorney's Office, it is comprised of several sections or individual laboratories. The first section is devoted to Chemistry. The greatest number of cases examined here have to do with the identification and analysis of narcotic materials. An article dealing with this subject will appear in a future issue of this journal. Other matters demanding the attention of the chemist concern the identification of unknown chemical materials, the examination of blood to determine alcohol content, and the identification of certain poisonous materials.

Another section is the Firearms Identification Section. Everyone who watches television or reads detective stories is aware of the prominence of firearms in the commission of crimes. As a matter of fact, fictional stories of this type bear little relationship to actuality, but in this instance they bear out one fact, and that is that firearms frequently do come to the attention of the police in the investigation of crime. The task facing the crime laboratory is to determine if a certain weapon was used to fire a particular projectile or cartridge case. The offense may be murder, assault, armed robbery and the like, and the evidence may consist of a fired bullet or cartridge case plus a weapon taken from the suspect. The firearms examiner fires cartridges in the suspected weapon and recovers the projectile and the case in an undamaged condition. These are compared with the bullet from the body, or the cartridge case from the crime scene, with a comparison microscope. A positive comparison will allow the examiner to say that both bullets or cases were fired from the same weapon. Other problems facing the examiner from time to time consist of the determination of distance between the muzzle of the gun and the body at the time of firing, and the restoration of serial numbers obliterated with etching acids.

A similar problem is presented to the examiner in the comparison of toolmarks. Tools leave characteristic scratches on a metal or painted surface which, when compared with test marks made with a suspected tool, allow the examiner to determine whether or not it was the tool used. In a recent case by using this method and utilizing the comparison microscope, a tool recovered from the trunk compartment of a suspect's automobile was found to have been the tool used in breaking open a safe.

The Microanalytical Section contains the equipment necessary to allow the maximum amount of information to be determined from many different kinds of evidence. Here paint fragments may be compared microscopically, debris from clothing will be studied and its components isolated for further examination, hairs and clothing fibers may be compared at high magnifications, soil from a suspect's shoe may be compared with that from the crime scene, wood particles may be identified, blood and other physiological stains may be identified, and so on. In a recent hit and run case the evidence, which was identified and compared with known materials, consisted of headlight glass, automobile paint, clothing fibers, fabric sections, and fabric impressions in paint and blood. Under circumstances such as these the information available from "things"

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A CAREFUL STUDY of blood stains may allow a reconstruction of the crime.

Radio Script

The Chemistry of Proteins and Nutrition

• **By Dr. Harold Wooster and Mr. John Nair, III**
THE MELLON INSTITUTE OF INDUSTRIAL RESEARCH, PITTSBURGH, PENNSYLVANIA

The Pittsburgh Section of the American Chemical Society conducts weekly science broadcasts over Radio Station WCAE under the collective title "Chemistry and You." With permission, the script used March 19, 1955, is here published, to discover if it may find use elsewhere, or if it may serve as a pattern for radio or assembly programs on other science topics.

Reader reaction will help the Editor decide whether additional scripts of the series shall be made available.

Dr. Wooster's comments are in Roman type, Mr. Nair's in italics, throughout.

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ANNOUNCER—Once again we bring you "Chemistry and You," presented by the Pittsburgh Section of the American Chemical Society. This evening Dr. Harold Wooster of Mellon Institute will speak on "The Chemistry of Proteins and Nutrition." Dr. Wooster has written a pamphlet, "Facts About Foods" which tells the story of foods and nutrition. At the end of the program you will find out how you can get a copy. The representative of the American Chemical Society who will appear with Dr. Wooster is John Nair, also of Mellon Institute.

WOOSTER—Take a cup of water. Stir in ten teaspoonfuls of sugar. What do you get? A sirup. Yet this cup of water will contain 30 per cent of solids—the same amount of solids as the human body. Man is 70 per cent water.

NAIR—Why, then don't we flow as freely as that sugar solution does? Why doesn't our flesh melt, thaw, resolve itself into a dew?

Because we have proteins. Proteins can bind large amounts of water into themselves, forming semisolid jellies. Anyone who has made gelatin dessert knows this. A small amount of dry protein, gelatin, soaks up a large volume of water and produces a semirigid mass.

The protein molecule is nature's masterpiece of complexity. In the elaborate pattern of that molecule is locked the secret of life. The proteins are the mechanics of life—they fabricate its tissues, regulate its energy and assure its perpetuation.

Every protein is different, yet all are made of the same things. Egg white, cheese, hair, and fingernails all are made of proteins. Boil a protein for twenty hours in strong acid. It loses its identity and its special properties. The building of the protein molecule has crumbled into the bricks it was made of. These bricks that we find are the amino acids.

Arginine and histidine, sulfurous methionine, phenylalanine and tryptophan, some twenty-two all told; these are the amino acids.

There are only twenty-six letters in the alphabet, yet look how many tens of thousands of words can be made by combining and recombining them. Just so do twenty-two amino acids make up the proteins.

A freight train is made up of box cars and hopper cars, "reefers" and gondolas—all different but all alike. Each car can couple to the car before and behind it. Just so do the amino acids couple to each other.

The various amino acids differ in their chemical patterns. However, a small part of their structure, the part by means of which they are joined together, is repeated in each one. To achieve a union, two amino acids come together and shed a molecule of water. Part of the water molecule comes from the hook of one amino acid and part from the eye of another. The forces which once had held onto the atoms which formed the water now graft the two amino acids together. But only the eye of one amino acid and the hook of another have been engaged, leaving one eye and one hook free to join with other amino acids. Two more can join on, and two more after that until hundreds of amino acids are linked to form the huge chain which is a protein molecule.

Cell and tissue, organ and organism—all are built from protein molecules. Let us consider man. He is born, weighing perhaps eight pounds. In five months he doubles his birth weight—in a year he triples it. At maturity he may weigh 170 pounds or more. All this has come from the food he eats, the water he drinks, the air he breathes. How is this done? What proteins must he eat to grow?

Biochemists found that animals on a protein-free diet lost weight, and died unless they were rescued with meals of proteins. They then took a wholesome protein, casein from milk, and cooked it with acid until it was whittled down to its amino acids. When this mixture of amino acids was fed to rats they thrived. After all, what happens to proteins in the alimentary canal? Enzymes break them down into amino acids. Animals do not absorb whole proteins into their blood streams—they absorb only the amino acids. Whether the protein is crumbled down in the flasks of the chemist or by enzymes in the stomach apparently makes no difference—it is the amino acids and not the whole protein which is essential.

Are all amino acids of equal value? How can this be tested?

Biochemists first turned to natural proteins which were known to be lacking one or more amino acids. Gelatine is such an incomplete protein. Three amino

acids are completely missing from it, and two others barely put in an appearance. Zein, a protein from corn and gliadin, a protein from wheat, are both lacking in some amino acids. Rats cannot live on a diet complete in every other way, but containing as the only source of amino acids these impoverished proteins. Their growth is stunted, and unless help comes in time they die. The help is either a wholesome protein like casein or the original incomplete protein fortified with the missing amino acids.

This can take care of a few amino acids, but what about the rest? It would seem to take twenty different proteins, each lacking just one amino acid. Then we could conclude that those proteins which did not support growth would lack an essential amino acid.

Unfortunately, nature did not design her proteins for the convenience of the biochemist. We had to sort out the essential and nonessential amino acids the hard way. This job was started about twenty years ago by Dr. William Rose, a biochemist at the University of Illinois. Dr. Rose decided to keep rats on a collection of pure amino acids rather than on proteins. In this way he could leave out one amino acid at a time, and study the effect of the omission on his rats.

Only a few of these amino acids could be bought, and those were prohibitive in cost. Rose and his graduate students labored long at the accumulation of amino acids. Some they isolated from mixtures of amino acids obtained from proteins; others they made synthetically in the laboratory. How simple that sounds! But what a tediously difficult task it was, even for the expert hands of scores of graduate students trained in that remarkable school of chemistry.

When all the known amino acids were assembled, they were fed to rats which were receiving no proteins at all. The rats didn't grow! They could be made to grow only if the amino acid mixture was supplemented with a bit of casein. Dr. Rose concluded that something else besides the twenty known amino acids must be present in casein, and that this unknown amino acid was also essential for the rats. To track down the unknown factor, he began one of those long careful searches which is an occupational hazard of the biochemist.

Casein was cooked with acid, and the resulting amino acids put through a variety of chemical separations. Each of these fractions was fed to rats along with their diet of amino acids. When one particular fraction was added to the diet of known amino acids the rats grew. This fraction yielded a brand new amino acid of whose existence we had not even dreamed. When the new amino acid was fed, together with the known ones, the rats thrived.

Then he started a group of rats on a diet containing all the amino acids but one, and he measured their growth. Another group of rats was put on a diet lacking another one of the amino acids, and this was repeated until all of the twenty-one amino acids had their turn at being left out of this most elaborate game of musical chairs.

Ten different groups of rats failed to grow; ten amino acids are essential to the rat. They can do without the other eleven amino acids, but if just one of these ten essential amino acids is missing the rat behaves as if it were receiving no protein at all; it cannot grow. The rat's need for protein, then, is the need for these ten essential amino acids.

But what about man? After all, we are interested in what man must eat. What are man's need for amino acids? Do we know anything about them?

To find these answers, Dr. Rose turned again to his graduate students. Only this time he fed *them* the amino acids, and determined whether the proteins were being used by analyzing the urine for its nitrogen content. For proteins contain nitrogen, and when a person is fed an incomplete protein, he excretes much more nitrogen than he takes in.

But what did the graduate students actually eat?

Most natural foods contain significant quantities of proteins and amino acids, and would influence the experiment. The diet consisted only of highly purified amino acids, starch, cane sugar, butterfat, corn oil, inorganic salts and vitamins. The amino acid mixture, which was composed of the ten amino acids previously found to be necessary for the growing rat, was taken in solution flavored to taste with filtered lemon juice and sugar. One-third of the day's rations was consumed slowly at each meal. The starch, corn oil, inorganic salts, most of the butter and a suitable amount of baking powder prepared in the laboratory were mixed with water and baked into wafers. The remaining portion of butter was used as a spread for the wafers. The graduate students could live indefinitely on this mixture.

But, if a single amino acid was omitted from this mixture—what happened then?

The students promptly fell into negative nitrogen balance—that is, they excreted more nitrogen than they took in. Their appetites failed, they felt very tired and irritable. These changes took place even when the subjects were aware that an amino acid had been omitted. When the missing amino acid was restored to the diet nitrogen equilibrium was reestablished and the students promptly felt better.

Does man, then, need the same amino acids as the rat?

Normal, adult humans can get along without arginine and histidine, two of the amino acids that the rat needs for growth and maintenance. They are not needed by adult humans. The other eight essential amino acids are needed by both man and rat.

This is all qualitative. Is there any quantitative evidence? Is there any precise measurement of the exact amounts of the various amino acids needed by man?

After Dr. Rose had determined which amino acids man needed, his next step was to find the smallest amount of each of the eight essential amino acids which would keep his graduate students in nitrogen balance. The composition of the diet was kept constant with respect to seven of the acids while the eighth was lowered step by step. When the level was so low that the students went into negative nitrogen balance, more of

(Continued on Page 79)

A Student Fluorescence Meter

• By Professor Margaret W. Greene *and* Dorothea A. Ageledis
DEPARTMENT OF CHEMISTRY, ELMIRA COLLEGE, ELMIRA, NEW YORK

A construction project successfully carried out by a senior student under the direction of a member of the teaching staff of a well known college of arts.

Inexpensive teaching devices of permanent value that challenge the interest of college students and can be built by them are not easy to find.

Here is one to interest both teachers and students.

●

Fluorescence is a form of light emission produced when the molecules of a substance are changed from their normal energy level to an excited state. This may be accomplished by exposing the molecules to a high energy source such as ultraviolet radiation. The mineral fluorspar, chlorophyll extract, the dyes eosin and fluorescein, and the vitamins thiamin and riboflavin are examples of substances which exhibit fluorescence under ultraviolet light.

To measure the fluorescence of a substance, expose it to ultraviolet light which causes the substance to fluoresce, or emit visible light. This light strikes a light sensitive surface, such as that of an ordinary photocell. A small electrical current, which is proportional to the quantity of visible light, develops in the photocell. This current is then measured by a galvanometer or a microammeter. Since the intensity of fluorescent light varies with the concentration of the substance under examination, it is possible to make a quantitative estimation of small quantities of the substance being analyzed.

The fluorescence meter described below was constructed by a student in a semester course at Elmira College titled "Independent Study" which is open to qualified seniors. The purposes of the construction were to illustrate the principles on which a fluorescence meter operates, and to construct a usable instrument that would later become part of the permanent equipment. The materials used are either inexpensive or they are standard departmental equipment which is generally available because it is used for other purposes only occasionally.

Materials

18 inch, 15 watt fluorescent ultraviolet lamp GE F15T8BLB about $3.55)[1] (General Electric *Lamp Bulletin* LS-103, July 1949, p. 5).

Plug-in ballast for lamp.

2 fluorescent lamp sockets including one starter.

Sample container-constructed from strips of thin window glass cut to desired size and fastened with Duco cement.[2] (Boltz, David, Editor, *Selected Topics in Modern Instrumental Analysis*, Prentice-Hall Inc., New York, 1952, p. 89).

2 Weston Photronic Cells with holders (Central Scientific Co.) These will be replaced by rectangular selenium photo cells.

Sensitive galvanometer (such as GE portable type 32C2G with 4" scale) or a microammeter.

Decade resistance box having a maximum resistance nearly equal to the internal resistance of the galvanometer or an inexpensive radio potentiometer.

Construction

Lamp housing: A box measuring 18½" by 3½" by 3½" was made from light plywood and painted inside and out with aluminum paint to reflect maximum ultraviolet light[3]. (*op. cit.*, Boltz, D., p. 72) A hole was bored in the center of the back and a ⅜" iron rod 4" long bolted in place. This rod was then clamped to a ring stand. Two narrow strips of aluminum were nailed to the long front edges of the box to hold the light filter and a removable shield made from a sheet of aluminum. A slot 4" by 2" was cut out of this sheet to allow ultraviolet light to enter the box containing the sample and photocells.

Light tight box: This box was made from plywood and painted inside with flat black paint. It measured 10" x 6" x 5" inside and had a removable cover. A 4" x 2" slot was cut in the center front. A small hole to permit passage of wires was bored in the back near the bottom. Figure 1 shows the dimensions and placement of the wood blocks used to support the photocells and sample container.

Filters: These were made by stapling colored cellophane to cardboard[4]. (*op. cit.*, Boltz, D., p. 78)

Procedure

The cells, galvanometer and shunt were connected as illustrated in Figure 2. It was found more satisfactory to use a fixed shunt and read the galvanometer deflection than to return the galvanometer to zero each time by varying the resistance.

To check the response of the instrument, stock solutions of eosin and fluorescein were prepared by quantitatively dissolving 0.1000 g. of the sodium salt in a

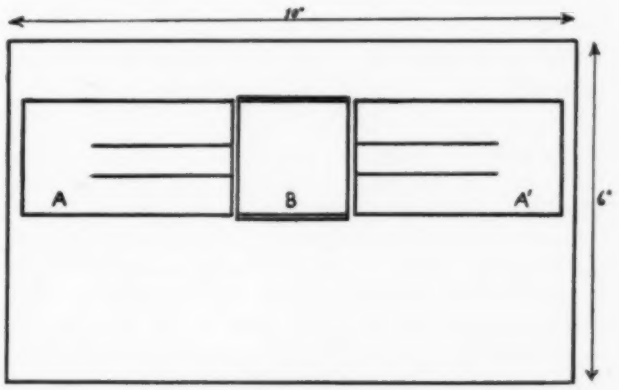

FIGURE 1.
Top view showing sample and photocell holders.
A,A' ¾" thick blocks slotted to fit Weston Photronic Cells.
B 1½" thick block with lips to hold sample container.

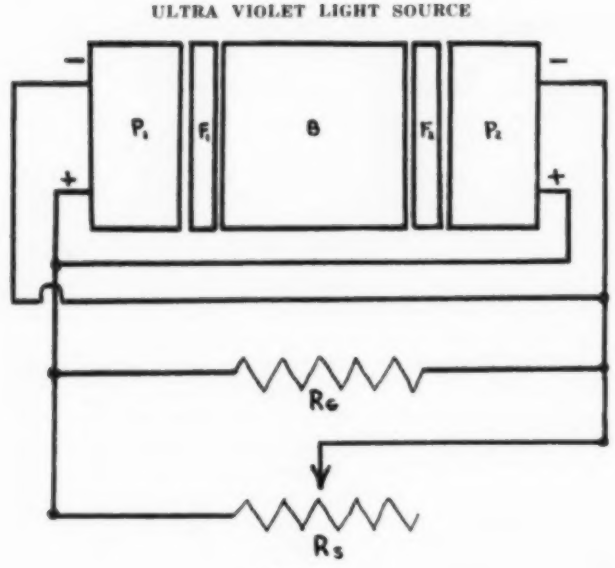

FIGURE 2.
Wiring Diagram
B Sample Container
F_1,F_2 Secondary Filters
P_1,P_2 Photocells
R_G Galvanometer
R_S Shunt Resistance

liter of water. Aliquots of the stock solutions of 2.5, 5, 10, 15, 20, 25 and 30 ml. were diluted to 250 ml. in volumetric flasks[5]. (*op. cit.*, Boltz, D. p. 100) These were stored in the dark in glass stoppered bottles.

With the secondary filters in place before the photocells the fluorescence of the most concentrated aliquot of the fluorescein solution was measured at different settings of the variable resistance. A resistance which gave a high galvanometer deflection was then used for all subsequent measurements of more dilute solutions. A plot of the concentration against the galvanometer readings was then made, (Fig. 3). "Unknowns" having concentrations which will fall on the straight line portion of the curve may then be prepared and their fluorescence measured. The concentration is read from the curve previously plotted by marking the galvanometer reading on the curve as at points A, B, C, D and E.

The experiments may then be repeated using eosin solutions.

Discussion

The primary red-purple filter[6, 7] (GE *Lamp Bulletin* p. 2) (*op. cit.* Boltz, D., p. 75) was not used, as it not only filtered out the visible light, but also did not pass sufficient ultraviolet radiation. No difficulty was experienced as a result of this omission[8]. (*op. cit.*, Boltz, D., p. 72) The secondary filters were constructed from orange colored cellophane[9] (Willard, H. H., Merritt, L. L., and Dean, J. A., "*Instrumental Methods of Analysis*, D. Van Nostrand Co., New York, 1951) for use with fluorescein and eosin. These were permanently attached over the faces of the photocells with masking tape.

Duplication and accuracy of results are possible if the following precautions are observed:

1. The positions of the sample container, the photocells, the filters and the light source should be fixed. Any variation in the position of one of these objects during an experiment causes a variation in the galvanometer readings.

2. The same volume of sample should be used for each reading.

3. A maximum surface of sample should be exposed to the exciting light.

4. A maximum surface of the photocells should be exposed to the fluorescent light.

5. The samples to be studied should be freshly prepared and readings obtained as quickly as possible after preparation. ●

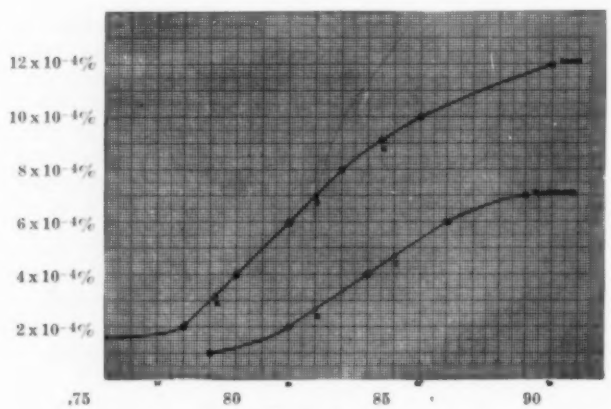

FIGURE 3.
Typical response curves of instrument to eosin and fluorescein concentration as ordinate *vs.* galvanometer reading as abscissa.

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Education directed toward wisdom, centered on the humanities, aiming to develop in people the capacity to think correctly and to enjoy truth and beauty, is education for freedom, or liberal education. Whatever his particular vocation may be, and whatever special training his vocation may require, every human being is entitled to receive such a properly human and humanistic education.

—JACQUES MARITAIN

★ ★ ★ ★ ★

"One of the startling paradoxes in American public education is the comparatively high degree of respect the teacher receives from the parents of the children in her room, as manifested by the long lines of earnest-faced parents seeking interviews at PTA nights and similar occasions, as compared with the comparatively low degree of respect which the teaching profession as a whole enjoys with those same parents, as evidenced by poor support for schools."

Francis C. Pray
University of Pittsburgh

Metals We Eat

• By J. F. Wischhusen
CONSULTANT, INORGANIC BIOELEMENTS, INCORPORATED, CLEVELAND, OHIO

This article discusses the importance of minerals as foods.

More and more we are learning of man's need for minute amounts of various elements if he is to maintain good health. Such essential trace elements are obtained through the foods in which they are found and which they acquire either directly or indirectly, from the soil.

Do you have the salt habit?

●

All life, vegetable, animal, human, depends upon inorganic materials commonly called minerals. These may be of geologic, marine, or even atmospheric primary origin. Animal and human life differ from the plant world in their greater requirement of organic foods, such as carbohydrates, proteins, fats, and vitamins. But minerals are necessary for every kind of life. According to evolutionary theories, rocks and mineral salts existed before either chlorophyll or hemoglobin. In our study, therefore, minerals logically should have priority over the complex organic compounds for whose synthesis minerals are essential.

In recent years the concepts of balance and totality have pervaded the thinking of biochemists and nutritionists, not only in the big five group—carbohydrates, proteins, fats, "minerals," and vitamins-hormones-enzymes (as one family)—but also within each group.

The term "total digestible carbohydrates" does not indicate the proportion of individual sugars, vitamins, hemicellulose, etc., that compose a food. "Total protein" is meaningless without a knowledge of the individual amino acids that are present. Fats are a matter of specifying the fatty acids they contain, and whether they are saturated or unsaturated. In the same way "minerals" is clearly a collective noun applied to raw materials for industrial purposes; therefore, the expression should be avoided where nutrition is concerned. The proper term is ions, the form in which they occur in water solution. Some ions appear to be held in combination with living tissue.

Many inorganic ions are so widely distributed in foods of animal, plant and marine origin that little concern has ever been felt about a shortage of them. In fact, until quite recently it was thought that most of them were contaminants. Refined foods, from which these "impurities" have been removed, are still looked upon by many people as an improvement in nutrition. But it is gradually being recognized that these inorganics play an essential role, and that when they are absent or even deficient in amount, ideal physiological conditions exist for pathogens and parasites to invade the animal body.

On the other hand, the human body possesses great tolerance for certain foods, among which are some of the mineral salts. Man has formed the sodium habit, for example, perhaps on the theory that if a little is good, more is better, especially if it is palatable. But there is evidence that the universal sodium habit has caused a depletion of hydrochloric and phosphoric acids, besides an imbalance of potassium, magnesium, and calcium. The persistent ingestion of foods and beverages containing carbonic acid may be responsible for the high blood carbonates that are deposited as cysts, fibroids, etc. These are physiological rather than pathological conditions that can be detected and corrected by elementary chemical methods.

The concept "balance" as well as quality, has many meanings and can be made to apply to different objectives.

The life of the sea is "balanced." This was aptly reported in *Life* magazine, November 30, 1953. In the sea, as on land, all plants obtain their nourishment by converting inorganic substances, water, and carbon dioxide into food. The process, photosynthesis, depends upon the energy of the sun. The individual atomic elements contain such energy as has been stored within them during the ages. Unlocking this atomic energy may be considered equivalent to utilizing the sun's energy that has accumulated on our planet. The earth is one tremendous storage battery.

Simple inorganic substances are converted by plants into complicated compounds such as sugars, starches, proteins, fats, that provide nourishment and energy for animals. All marine life originally was a single-celled microscopic plant called the diatom. This in turn forms planktons that include numbers of protozoa which are one-celled animals, dinoflagellates—half plant, half animal. Plankton is the food factory of the sea, and from it emerge the many forms of life that inhabit the seas which encompass 300 times the habitable cubic space of our land and fresh water areas combined.

In the sea there is an endless chain of food production. Every free swimming creature—as stated in *Life*—lives on the flesh of others smaller than itself. It is estimated that 10 lbs. of food are required to build one pound of the animal that eats it. Thus it takes 10,000 lbs. of diatoms to make 1,000 lbs. of copepods, to make 100 lbs. of herring, to make 10 lbs. of mackerel, to make one lb. of tuna, to make 1/10th of a pound of man.

Since the open sea provides no repository or hiding place for food, each meal must be caught and eaten alive. So the ocean population is involved in a never ending cycle of eat and be eaten, pursuit and flight. Each living creature in the sea is hunter and hunted, feeder and food, predator and prey. When an animal dies or is torn asunder its remains sink to the bottom

where they are consumed by scavengers or decomposed by bacteria. Then they become detritus, either to be consumed again by detritus feeders (saprophites) or wafted aloft through upwellings to provide dissolved fertilizer for the diatoms on the surface waters. And so the food cycle of the sea is eternally renewed. Here, then, is an established balance as well as totality of life below the surface of our earth that can be investigated.

Conceivably, therein is contained every known element in the form of dissolved salts or other simple compounds. Evidently the ability of various forms of marine life to select their own entirely different requirements of nutrients from a rather uniform composition of sea water is well adjusted. Although he cannot utilize natural sea water for its nutrients, man has selected salt, sodium chloride and other sodium compounds, as the principal mineral, and has acquired a so called "sodium habit."

Above the surface of the earth life exists at the bottom of an ocean of atmosphere. Those who believe in "'health from the ground up" may see a parallel in the chain of food production in the sea from the lowest to the higher forms of life. "All flesh is grass" may parallel "All fish is plankton," but there the analogy ends. Otherwise, it might be argued that our bird population would possess the greatest advantages in this atmospheric ocean. Instead, the apex of the pyramid of life is occupied by man, who is distinguished by his ability to record and disseminate thoughts and experiences and to convey them to succeeding generations. These qualities are not at the disposal of other forms of life; indeed, not in the same manner at the disposal of all mankind.

So the concept of balance of life above the surface of the earth is not comparable with the balance of marine life, nor can it be applied to the vegetable kingdom and the lower forms of animal life. Ever since man learned to unravel the secret of the atom and make use of the energy stored therein, any evolutionary or biological balance must be concerned with atomic energy.

We are told of the healthy Hunzas, how they enjoy robust health, longevity, great strength and endurance. The reasons for this can be ascertained by analytical means when a technique is found to ascertain them. But, seemingly, no one rushes to live the lives of these famous people, nor do the Hunzas have to their credit arts and sciences that enable them to travel around the world in railroads, ships, motor cars or airplanes. There is no literature by which the Hunzas have seen fit to attempt to teach the rest of mankind how to live as long as they do. The Eskimos, too, when assured of their food supply, enjoy perfect health, and are therefore well nourished and largely carnivorous. They are an intelligent people but they have nothing to their credit in the way of conveying to others the facts that make them healthy. In fact, one of the limiting factors in their rather short life-span has been their teeth, used not only to chew their food, but to manufacture equipment with which to clothe and transport themselves. So, to them, some of their greatest blessings in comparatively recent times have been the needle, the knife, and the gun, none of which were ever conceived by them. The native American Indian was a son of nature until the white man came. There appears to have been a balanced population of an estimated 3 million people based on the available food supply of "nature." But the principle of the wheel was unknown to him so that he proved no match for his white cousins and others who had invented the principles of transmitting and utilizing energy by mechanical means that now support about 160 million people in the same territory. "The reserves of civilization are the savages" has been a principle handed down from the days of the Roman Empire, but our scientists now concede that if for any reason humans and other higher forms of life on this earth were destroyed, evolution would not replicate them. There are those who say that the evolutionary methods of the past will give way in future to the principles of exact science that govern genetics and nutrition. It is of course natural that the art of agriculture, feeding, and eating should precede the science thereof. Man's new knowledge must be expected to be applied for his own benefit, but it can also be used for his destruction. There is evidence that ancient civilizations were destroyed by certain limiting factors of their time.

We shall have to use the chart of the known atoms as a unitary chemical basis, as our alphabet as it were. These atoms are the smallest part of an element to remain unchanged during a chemical reaction, and are thus chemically indivisible and indestructible. But it will now probably also be necessary to study the force within the atom, that which holds it together, or is liberated when an atom disintegrates or is transformed. That this offers endless possibilities is easily visualized.

A "balance" of life from this view point is hardly in sight for man. Recorded history shows that progress of man's intellectual ability was largely predicated upon self interest and power. Physical manpower went out with the discovery of firearms. Mental acumen has placed man in possession of atomic weapons. A small numerical minority developed mental power to harness atomic energy, something based on absolute exact physical equations that can be calculated. Mathematics, therefore, is the proven ultimate exact science, and self interest demands that those who are capable perpetuate, enlarge and apply this science. There can be no question that the same principle of exact science also governs genetics and nutrition and that this will render obsolete many of the prevailing concepts about the soil-plant-animal-human relationships of health.

It must always be reiterated that each form of life is only concerned with its own growth and reproduction. The lower forms are not mindful that they serve the purpose of food for the higher forms. If they do it is merely accidental. The human body containing the mental power to unravel the atom and make use of its latent energy is not a normal product of nature. Man is more likely the result of adversity, which he learned to capitalize in his own interest. For this reason the quality of man compared with the health of man, is difficult to epitomize. Longevity, wealth, physi-

(Continued on Page 65)

New Books

Relativity for the Layman

• *By* JAMES A. COLEMAN. New York: The William-Frederick Press. 1954. Pp. 131. $2.75.

This book lives up to its title. The science teacher and the science student cannot afford to miss it. It refutes pointedly the preposterous claim that only a very few persons in the world are intelligent enough to comprehend Einstein's theory of relativity. Here in simple language that almost anyone can understand is a lucid, non-mathematical explanation of the theory and the reasoning on which it is based. The author's gift for clear expression, his use of apt analogies, and his humorous illustrative drawings all make for easy and pleasant reading.

The velocity of light and various means for its measurement are first discussed. Then consideration is given to the ether—whether or not it exists, and if it does, why workers in the field fail to detect it. Einstein's special and general theories are then explained in some detail. Expert proof is offered in support of both. The final chapters consider the nature of the universe and the unified field theory.

Recommended for the high school library, and the public library as well.

H. C. M.

Introduction to Philosophy

• *By* MAX ROSENBERG. New York: Philosophical Library. 1955. Pp. 502. $6.00.

In this book the author endeavors to make the reader acquainted with philosophy in non-technical language, "in the King's English," as he calls it. To reach this purpose he proposes as simply as possible the various positions taken by philosophers with respect to some of the problems of philosophy, such as the nature of philosophy, knowledge, reality, life, God, man, right and wrong, beauty and the good life. Generally, it is left to the reader to make his choice among the many conflicting views, whether it be on the existence of God, immortality, suicide or the validity of knowledge.

For one who wants to become seriously interested in philosophy the work would seem to be too superficial and sketchy. But it could be useful for those who want some information about philosophical matters without having to make too much mental effort.

Henry J. Koren, C.S.Sp.
Department of Philosophy
Duquesne University

Botany: *Principles and Problems*

• *By* EDMUND W. SINNOTT and KATHERINE S. WILSON. New York: The McGraw-Hill Book Company, Inc. 1955. Pp. 528. $6.75.

The fifth edition of this well known botany text is more comprehensive than former editions in that new chapters have been added and others have been enlarged as well as revised. The twenty-six chapters in this book cover every phase of Botany. The system of classification followed in the survey of the plant kingdom includes only three phyla, the Thallophyta, the Bryophyta and the Tracheophyta.

The text is written in a pleasant style, incorporating many interesting data not usually found in formal texts. Following each chapter are questions many of which are excellent for stimulating good class discussion. Such data and questions in a text insure that the student will meet abundant botanical information even if his teacher is inexperienced or has only a minimum of botanical training. However, such data and questions tend to detract from the climaxes of the dynamic teacher who usually enriches his lectures with similar material. The subject matter is liberally illustrated with superb photographs and lucid diagrams. High school students who may not understand the text will enjoy the photographs and the diagrams.

Helena A. Miller, Ph.D.
Department of Biology
Duquesne University

Energy Metabolism and Nutrition

• *By* RAYMOND W. SWIFT and CYRUS E. FRENCH. Washington, D. C.: Scarecrow Press. 1954. Pp. 264. $5.75.

The title of this book may be misleading in view of current biochemical terminology. It is not a discussion of the fundamental thermodynamics of metabolism at the cellular level but is based on the principles and methods of direct and indirect calorimetry in the intact animal. Appropriate sections on factors regulating or resulting from metabolism are presented and include such topics as endocrinology, acid-base balance and body temperature. The authors assume that the reader is familiar with the detailed biochemical and physiological backgrounds of metabolism and nutrition. For this reason, the content is too advanced for the beginner and inadequate for the advanced student of nutritional biochemistry. The book will serve as a useful guide in principles and methods of calorimetry

for nutritionists and dieticians. An Appendix is included with questions and answers, as well as conversion tables and other data relative to the experimental measurement of metabolism and nutrition.

John G. Adams, Ph.D.
Department of Pharmacology
Duquesne University

Politics and Science

• *By* WILLIAM ESSLINGER. New York: Philosophical Library. 1955. Pp. XI + 167. $3.00.

The keynote of this book of moderate documentation and index is "scientific thinking to practical politics." The "sciencing" of politics is here held as the key to the solution of world tension which the tremendous disparity now existing between the revolutionizing progress of physical science and technology on the one hand, and man's politics which lags behind on the other hand has created. It is a thought provoking essay, in which the erudition of the author is visible throughout. Despite the main theme of "sciencing," the general approach is philosophical, and at several points the reading becomes heavily involved requiring considerable understanding of the philosophical and technical implications of politics.

Mr. Esslinger ascribes the human predicament of our time to man's inability to adapt politically to the unique situation created by the advent of the atomic age. The uniqueness of this age lies in the enormity of physical force capable of unprecedented destruction and the polarized world politics characterized by a war of systems and ideologies. The extreme gravity of the cold war which now locks East and West in a deadly struggle is in direct proportion to the unlimited destructiveness of modern weapons. This titanic force controlled through scientific mechanism—a highly flimsy one in nature—may be unleashed at any moment for want of a solution resolving the political differences of the nations. The gruesome fact is that "new form of warfare, total war, . . . disregards the old legal and moral rules for the protection of civilians, . . ."

Politically, it is contended, human adaptability has been hampered by the multiple forms of human prejudices, germinated and nurtured by the irrationality of man's thinking and behavior in politics. The difficulty is further enhanced by numerous negative factors inherent in politics precluding the possibility of accurate measurement of man's political achievement.

What is the alternative in politics which may render man more adaptable, thus enabling him to keep pace with the progress of the physical sciences? The author insists it to be the "sciencing" of politics. The distinguishing feature of the term "sciencing" as employed here by the author is that "it is exclusively and methodically based on reason." The subject of politics, as Mr. Esslinger puts it, is in the main concerned with "organization of political bodies," *viz.* the State. And the insolvables in politics, domestic and international, may be solved when man through the "sciencing" of his political activities becomes rational.

To this reviewer, Mr. Esslinger made a definite contribution toward the solving of the perennial issue of bringing the infinite into a contact with the finite and a theory with practice. On the other hand, a question may justly be raised on the validity of the thesis that the ethical factor has virtually no place in politics and that the motive force of man's action in politics is something other than reason, hence its susceptibility to empirical method which the author coins as "sciencing." It is not argued here as to the prevalence of man's irrational behavior in politics, whether it is domestic or international. However, it would be highly erroneous to assume that the prevailing confusion of thought is the consequential phenomenon of weak scientism applied to politics. Rather, it would appear that such confusion is the direct reflection of man's ignorance with regard to his purpose as a rational creature, and the growth of secularism which has been destroying the rich heritage of Christian civilization. There may be a rightful province in politics which can be subjected to the process of sciencing, but a consideration of even more profound import is that which is moral and spiritual.

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Duquesne University

An Outline of Atomic Physics
(*Third Edition*)

• *By* OSWALD H. BLACKWOOD, THOMAS H. OSGOOD and ARTHUR E. RUARK. New York: John Wiley and Sons, Inc. 1955. Pp. X + 501. $7.50.

The third edition of this book has been revised extensively in order to record the tremendous advances of physics in recent years. Chapters 10 through 13 concerning nuclear phenomena include such important developments as the theory of nuclear forces, nuclear magnetic resonance, production of fast changed particles and utilization of nuclear fission.

This book is intended for students who have completed a year's work in college physics and are familiar with elementary mathematics. The contents are divided into fifteen chapters dealing mainly with atomic and molecular structure, the nature of radiation and the theory of relativity. Various topics are discussed in a simple, clear manner, easily understandable by beginning students. The significance of basic principles is stressed and lengthy mathematical treatment avoided. For instance, Schroedinger's wave equation is introduced and discussed considerably without using partial differential equations. The authors have given a collected bibliography and a list of problems at the end of each chapter.

Brevity is expedient in covering the various phases of atomic physics in a book of this size; however, a few important topics such as the Zeeman effect, Russel-Saunders coupling, and theory of specific heats seem to have been oversimplified. A short chapter covering the elements of statistical mechanics, because of their wide applications in photoelectricity, thermoionics, radiation theory, etc., would have been of considerably greater value than the short discussion on pp. 261-262. This reviewer feels that it would be more beneficial to introduce the theory of relativity, chapter 15, earlier in the text.

This book satisfies the needs of a text for junior instruction and should give the student a correct perspective of the growth and present trend of modern physics.

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Duquesne University

★ ★ ★ ★ ★

Physics, like mathematics, if it is viewed in the creative power from which great discoveries proceed, is close to poetry. If it were taught as it demands to be, in the light of the spiritual workings of man, it should be revered as a liberal art of the first rank and an integral part of the humanities.

—JACQUES MARITAIN

Metals We Eat

(Continued from Page 62)

cal excellence, mental power, progenerative power and freedom from disease, are all qualities that characterize man, but they are hard to relate to any particular diet or source of diet. World history has been made by public men who were in anything but "normal" physical and mental health. According to the late Professor E. A. Hooton of Harvard, man reached his greatest physical perfection and development 30,000 years ago. Man, today, by that standard is a product of degeneration. So presently we have this paradox of ever higher mechanical perfection of the gadgets of civilization, and ever more physical degeneration as evidenced by the increasing numbers of neurotics, and cardiac, cancer, polio, etc., sufferers. The purpose of applied nutrition must be to coordinate these divergent trends.

Nature cooperates as intelligently with parasites and pathogens as with their hosts. What is detrimental to the former is beneficial to the latter, and vice versa. And plants assimilate from soils nutrients without regard to their value as foods, if the plants are used as such; so no dependence can be placed on soils for the good health of man via crops. In fact, some essential nutrients cannot be secured from crops through soils at all. A classical example is common salt. The concentration of our modern requirement of salt for animals and men would kill the crops if an attempt were to be made to supply the need through crops from soils. This may show merely that we have learned to use salt to excess. Plants also assimilate toxic substances if they are in the soil. There are records of monstrous crops raised with "organic fertilizers" that were unfit for human consumption. There are more poisonous plants than there are cultivated food plants. Cotton, flax, tobacco, tomato, potatoes and other food crops can all be grown on the same soils from the same fertilizer. Organic fertilizers can only be produced from inorganic fertilizers, so the latter precede the former in function and importance.

Soils are source materials of foods as is the sea, but they cannot naturally balance themselves in composition as does the ocean. It may be said that there are no bad soils, only bad agriculture; no bad crops, but bad and imbalanced feedstuffs; no bad foods, but bad nutritional habits. Hence the basis for the existence of a fertilizer industry is the need to supply to soils the nutrients which the crops to be grown require but which the soils may lack. The feedstuff industry exists to solve the problem of assembling nutrients which animals require from all suitable available sources whether of agricultural, industrial or marine origin. In fact, as far as agriculture is concerned, the feed manufacturer competes with his own raw material. Finally, the highest objective of the nutritionist must be to determine the needs of man for optimum health, stamina or other objectives, and to recommend their assembly in suitable dietary forms from any available source. Since man is omnivorous, the sources of foods are immaterial and may be of marine, animal, plant, geological, and last but not least, atmospheric origin. The beneficial or detrimental effects of foodstuffs, are cumulative and faulty nutrition early in life, may manifest itself only in old age. While we cannot relate health from the ground up, we can co-relate the factors that produce a soil micro flora for the production of healthy plants in fertile soils, with the factors that produce a micro flora and fauna in the intestinal tract of healthy animals and man. Feed the microflora, it will feed you!

A study of these phenomena invariably brings us to the atomic elements, and compels us to learn of their formation into complex molecular structures as well as their transformation into elements of lower atomic weights through the reversion of radioisotopes into stable isotopes. The emission and reception of electrical impulses by atoms is as important as is their ionizing ability. The strength of the ion in any mixed fertilizer, feed, or food helps determine its assimilation. Since few atoms are found alone, we are concerned mainly with molecules that represent at least two atoms, two electric charges, an anion and a cation both of which are equally important but perform in different ways. Results from a metal therapy may be due to more than one cause. Wrong interpretations of the performance of atomic elements are sometimes due to a lack of consideration of these points. Nature does not tolerate independence; the best performances are obtained when all the essential elements are present.

Inorganic Bioelements

"Minerals" in animal nutrition are more properly referred to as Inorganic Bioelements. They constitute the vital five per cent of animal and human nutrition and serve as the foundation of body metabolism. Together with the proteins, carbohydrates, fats, and the vitamin-hormone-enzyme family they represent the "big five" group of total nutrients. Each group must be correctly balanced within the group, and the five groups must be balanced in relation to each other. *Optimal performances* in the growth, health, production and reproduction of domestic animals are otherwise not possible.

Calcium, phosphorus, sodium, potassium, chlorine, magnesium, manganese, iodine, iron, copper, sulphur, zinc, cobalt, bromine, fluorine—are the elements which compose the group classed as the "mineral" elements of nutrition. To that group can be added aluminum, arsenic, nickel and silicon as elements which occur very consistently in the composition of our bodies. These elements are interrelated and balanced against each other in body function and cannot be considered as single elements with circumscribed functions. For example, calcium, phosphorus, magnesium, and fluorine are in a definite relationship in the formation of bone and teeth. Manganese therein performs as a catalyst. Calcium, potassium, and sodium show definite relationships in the maintenance of acid base equilibrium, and in the physiological balance of the basic ions. Calcium and magnesium are related in the function of soft tissues. Copper catalyzes the use of iron, and cobalt and manganese influence both copper and iron in blood formation.

Ninety per cent of the ash of the body consists of calcium and phosphorus. Indeed, only these two elements approach one per cent of the total body composition. The relationship of calcium and phosphorus to each other and to the skeleton and teeth is pointed up by the fact that 99 per cent of the calcium in the body and 80 per cent of the phosphorus are found in the skeletal tissues and teeth.

With the disruption of normal "mineral" metabolism, severe and often dramatic changes in physiological and psychological reactions result. The minerals are the catalysts that make possible the functions of enzymes; they form the structure on which the body is built. When adequately supplied they make a strong healthy body possible. But they alone cannot guarantee this; the other four big groups must likewise be present in the food supply, all in correct and harmonious proportions. When they are absent, deficient, or improperly balanced in the total rations disturbances may result that resemble those caused by pathogenic agents, such as sterility, disease and unthriftiness.

Magnesium, as a nutrient, has been aptly dealt with in an article by S. Marcovitch of the University of Tennessee (*The Science Counselor*, December, 1954).

Manganese, copper, cobalt, zinc and iodine are the essential trace elements which, without question play roles in growth, resistance to many diseases, and in reproduction.

Nickel is quite obviously in this picture because the sources of cobalt invariably contain some nickel, and as can be seen from the table of the atoms these two elements are so interlocked that nothing can entirely separate them except perhaps their metabolism by plants and animals.

Fluorine is the subject of considerable unnecessary controversy because good bones and teeth cannot be formed without it. Late reports are to the effect that the thyroid gland is rendered more active by this element. But any source of fluorine cannot aid in bone and tooth formation unless all other essential elements required for the purpose are likewise simultaneously available in correct and harmonious proportions. Since bone and teeth formation start with the foetus, it is clear that all the essential elements should be present in maternal diets. Drinking waters are only one source of inorganic elements. They contain not only fluorine, but sodium, silicon, phosphorous, calcium, potassium, aluminum, chromium, manganese, titanium, strontium, iron, copper, lithium, barium, magnesium, in varying concentrations.

Supplements of any of them, especially to maternal diets, can be formulated for administration by the dental and medical professions. At Indiana University, research workers have found tin fluoride to be a superior source of metabolic fluorine. They also report studies that show the more active the thyroid the less tooth decay.

Boron, molybdenum, arsenic and lead are elements to which essential roles are variously attributed. This brings the number of elements herein referred to to twenty-eight.

Dr. Wm. R. Fearon in his book *An Introduction to Biochemistry*, classifies 37 different elements as in one way or another playing a role in the fabric of life.

The total of all known elements found present in soils number about 65, and those in various plants about 58. The late Dr. L. E. Walbum of the Danish Serum Institute experimented with metallic salts that embraced 47 different elements and reported beneficial effects from the use of most of them in conjunction with vaccines for the immunity to many different diseases. There can be no question that the sea, the soil and atmosphere account for all the 100 atomic elements charted or projected thus far. An expert would probably be required to thoroughly review each one of them for a possible positive or negative role in biological processes. But a world of experts would be a very unequal world indeed. A college of nutrition could best function to co-ordinate all this expert knowledge by practical applications in which faculty and students could be the subjects of their own experimentation. ●

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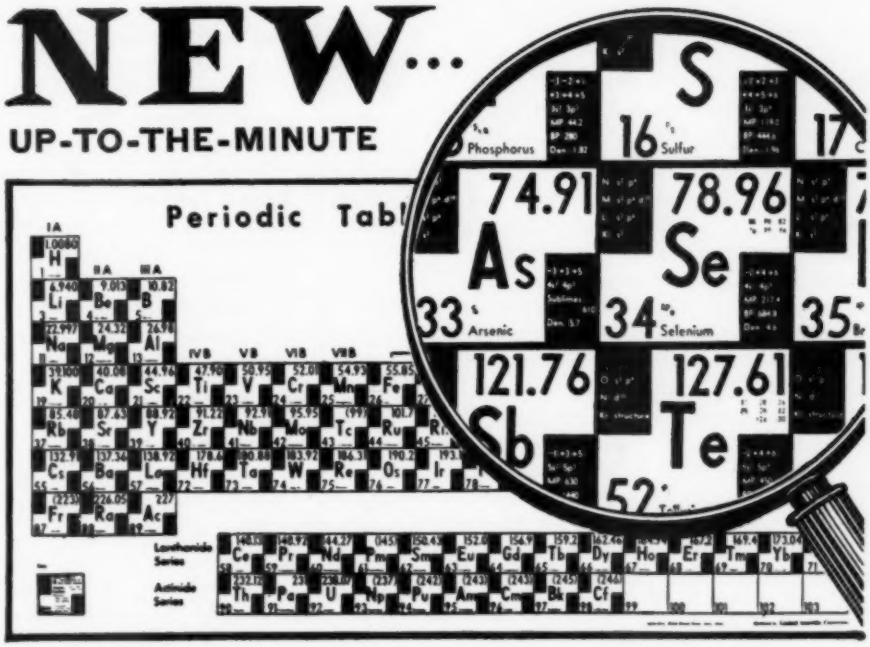

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Integration of Learnings

(Continued from Page 54)

of view. The strip mines of Pennsylvania gave rise to one of the most heated discussions on the problems created by certain scientific and technological advances in relation to the destruction of land usefulness and the aesthetic quality of the landscape The muddy rivers of certain areas as opposed to the clear rivers of others involved the group in problems of the availability of scientific data to people and their subsequent use or rejection of such data.

A third type of need for integration of ideas concerned the relationships of a particular situation to the need for further scientific research and planning. The great piles of bark from the stripping of pulp logs for paper seemed a tremendous waste of material to many of the students. Questions to the plant chemist indicated research in process but not yet profitable to the paper mill. The questions which followed then moved into the fields of transportation, competition and some problems already solved by the research division of the mill. A later humorous (but at the time most serious) abundance of cockroaches at one of the overnight stops developed much interest in the scientific data available for their control and elimination. This particular need for scientific data was not so much a research need in science as it was a definite research need for science information for the individuals concerned. The spokesman at the steel mill in Pittsburgh stressed the need for continuing scientific research to meet the rapid development of automation and necessary controls. This particular steel mill probably "stretched" the minds of the students as much as any other experience. The tremendous impact of technology and automation was almost beyond comprehension to most of them.

A fourth type of integration, rather nebulous to define and illustrate but nevertheless real, is a feeling for people and their concerns, which grows out of the impact of certain scientific data and research upon them. The automation of the steel mill gave rise to a certain empathy for people formerly employed, now relieved by technological advances. On the other hand, conversing with coal miners led to feelings of empathy for them in relation to their own job and the ways technology has aided them in their search for better conditions and security. This latter point is one which needs much development in our thinking if we are adequately to relate the advances of science to the effect these same advances have upon the lives of people and in turn upon the happiness and welfare of society in general.

As one might well infer there seems to be, on the whole, a provocative climate for learning on a regional study tour. What are some of the factors which are vitally important in enabling students to develop feelings of success in their learning on such a trip? The pre-planning is of primary importance. Having students take a major role in this pre-planning seems to be critical in insuring a readiness and receptiveness for the experiences they will encounter on the trip. The study tours have been developed almost wholly by students with faculty guidance. Student committees were set up on the route to be followed (the Route Committee), on the resources to be tapped while en route (the Contact Committee), on the study before starting (the Orientation Committee), on securing permissions from parents and college officials (the Permissions Committee), on making reservations for places to stay and eat (the Reservation Committee), and on evaluating and recording the trip itself (the Evaluation and Recording Committee). These committees studied possibilities, wrote letters, informed the class of their activities and worked together with the other committees. A steering committee composed of the chairmen of the various committees guided their cooperation. On the whole these committees command an amazing level of maturity; occasionally there is a need for serious education in responsibility.

A second factor of major importance seems to be the orientation study before the trip starts. This takes various forms. The outline as previously listed indicates the general approach. Sub-committees may undertake the preparation and presentation of various sections. Faculty leadership and that of other resource persons are frequently used. Audio-visual materials help in the presentation of ideas and information. The basic objective of this orientation is to develop and clarify some significant ideas related to the points to be observed later. Further understanding and integration can then take place as the students observe and discuss these ideas in action on the trip. A written guide has sometimes offered real assistance in refreshing memories and recalling essential information on the trip.

The third important factor consists of the selection of on-the-spot resource people to work with the group. State departments of education, chambers of commerce, local colleges and universities, labor groups and industries have all been most helpful in locating and providing such people. Informing these resource people of the purposes and needs of the group is necessary to insure meaningful interviews and discussions.

The final but surely not least important factor is the preparation the students have for living together on the bus, in cabins, in hotels, but always within close contact of the group. No rigid rules were set up, but long discussions helped to establish certain standards and certain attitudes which could serve as a basis for appropriate and mature action on the part of the students.

The implications of such study tours for students, both as citizens and as members of professional groups, seem manifold. To come to understand some of the myriad interrelationships of any particular region and community is a major task. The necessity for cooperative action between groups and regions, both of the United States and the world, bespeaks a strong need to have education assume its part in preparing students for this role. In the succeeding years the impact of

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ENERGY METABOLISM AND NUTRITION

by Prof. Raymond W. Swift & Prof. Cyrus E. French

Dept. of Animal Nutrition, The Pennsylvania State University

264 pp., illustrations, bibliographies. 1954. $5.75

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science and technology upon the world may well be determined by the intelligence which can be brought to bear in sensing its interrelationships with the land, the resources and the people. The individual disciplines of science will surely develop increasing amounts of scientific data but the unity of science and society will determine the final impact these data make upon the lives of the people and the progress of the world. ●

★ ★ ★ ★ ★

Freedom of Research

(Continued from Page 52)

rectly accessible to him or truth to which access is given only by means of Revelation. And when he makes a correct use of his reason, as is done in scientific work, his discoveries form a part of the truth and therefore can only be coherent with the whole truth.

For the believer, scientific research is not merely accepted in the name of a principle of intellectual tolerance, but also because it possesses a positive value which fully justifies the efforts which he consecrates to it when he engages in this research. The reason is not far to seek. The truth accessible to science is a part of the whole truth, and it is man's function to discover as much as possible of the truth, by using the means God has placed at his disposal for this purpose. Each time it is possible to use reason to perform a work of research, it must be used for it. For the believer, this application of reason to research is not an operation resulting from a curiosity which could, perhaps, be vain. On the contrary, for him, research assumes the appearance of a work that praises God. And he knows that he will be able to make his research a genuine work of praise if, and only if, he conforms scrupulously to the requirements of scientific research.

Freedom of Research in the Physical Sciences

As is clear from the foregoing, there are different attitudes, different lights if this term is preferred, and there is neither encroachment nor confusion. Positive science obtains its evidences solely from itself; it devises by itself its own methods and its own principles; it criticizes and corrects itself in the light of its own fundamental evidences; and thus it progressively fulfills the purpose which from its very inception it carried in its bosom. Without being totally closed, positive science is autonomous in the sense that it is constituted in the light of its own principles.

With respect to the research in which it engages, physical science is not subject to any external force in the intellectual order. It establishes its own laws, which it explores more and more and to which it gives increasingly more accurate formulations, and comes to a full realization of itself in a ceaselessly renewed fidelity to the requirements of these laws.

Not only is this research free, but of necessity it has to be free. As soon as scientific research would be directed by other principles than the proper internal principles of science, there would no longer be science. Such "research" would really amount to a negation of the fundamental attitude from which science originates. Accordingly, every attack upon its type of evidence would be an attack upon the very essence of science. The proper destiny of science is to bring to maturity whatever is implied in the attitude from which it has come forth, and the preservation of its autonomy is the very law under which this destiny can be reached. Once again, this law is an internal law of science, for as soon as a fundamental attitude is reached, we have regressed as far as possible and consequently cannot investigate any further.

Conflicts Between the Physical Sciences and Other Realms of Learning

The affirmation of the autonomy of the physical sciences is at the same time the affirmation of their limitation. If it is true that science can be itself only by rigorously preserving its autonomy, science would cease to be in conformity with its own nature and mission if it tried to go beyond the limits set down by its fundamental attitude or if it wanted to transgress its own order and lay claim to conclusions which do not depend upon its methods and evidences.

It is precisely when there is danger of such transgressions or when they actually take place that conflicts are likely to arise or do arise. It would be extraordinary, indeed, if physical science could arrogate to itself, even implicitly, another fundamental attitude without a protest of this attitude against such an intrusion. As a matter of fact, far from being a violation of the freedom of research, such a protest cannot fail to be its safest guarantee. Research is really free only to the extent that it obeys its own internal law. It would cease to be free as soon as, under the pretext of annexing a domain foreign to it, it would in fact subject itself to the control of another system of evidences.

This fidelity to its own law guarantees at the same time the efficacy of science. In order that research may achieve valuable results, it is necessary, of course, that it proceed in accordance with its own requirements. At the same time, however, and one could even say, consequently, care must be taken not to make any affirmations which go beyond that which is accessible to the methods of the research in question or beyond that which is encompassed by its evidences.

One may say that this vigilance which every fundamental attitude maintains in its work is a kind of isostatic mechanism which assures the preservation of the necessary balances and thus safeguards that each of these attitudes can separately reach its full development. This diversity of orders or fundamental attitudes is a principle of fruitfulness, but a principle which none of these orders is allowed to violate under penalty of causing its own perversion.

Of course, historically speaking, it was only progressively that this diversity became clearly established. In the course of time, there is room for moments of tentative efforts, when the methods have not yet been perfectly fixed and temporary misunderstandings may arise. In particular, this is what happened when the

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positive sciences gained their autonomy by detaching themselves from philosophy and becoming aware of their own attitude. At present, we are witnessing a phenomenon which is more or less of the same nature with respect to the social and psychological sciences. The methods of these sciences are only beginning to be clearly determined, and this determination can be accomplished only at the cost of a patient and laborious exploration in which the dangers of encroaching upon the domain of other realms of knowledge are very real. However, such phenomena are of a transistory nature. In the long run, the process of differentiation is brought to a close and then everything is seen in a clear light. ●

★ ★ ★ ★ ★

Science Versus Crime

(Continued from Page 56)

is conclusive and much more accurate than eye witness testimony.

Another tool available to the scientist assisting the policeman is the spectrograph. This instrument is designed to determine the chemical elements present in a given sample where the sample size is very small (e.g., about one-quarter the size of the head of a pin). This is done by burning the samples and recording the colors of light given off. These colors become the means of determining which of the chemical elements were in the sample. Paint, metal, glass, and certain poisons lend themselves to this type of examination.

The lie-detector is a valuable tool in the hands of an experienced examiner. The Polygraph(lie-detector) Section of the laboratory consists of one polygraph and additional auxiliary equipment that will allow the most effective use of this form of interrogation. The polygraph itself is a machine which records continuously blood pressure, pulse, respiration, resistance of the skin, and muscular movement of the subject during the period of testing. The subject, who must first agree to take the test, sits in a specially designed chair and answers "yes" or "no" to a series of ten or more questions. Some of these relate to the offense being investigated and some do not. By examining the recorded responses of the subject, the examiner can determine, with reasonable accuracy, whether he was telling the truth or not. In spite of the fact that the results of such a test are not admissible as evidence in court, a great deal of assistance has been provided the police in the evaluation of information at hand, and in providing investigative leads. In many instances suspects are cleared by the lie-detector. This frees the police to look elsewhere for the perpetrator of the crime, another instance of the laboratory protecting the innocent.

The document examinations required of the laboratory are conducted by a local consulting Document Examiner by arrangement. Forged checks, extortion notes, and other matters concerning writing, printing, typewriting, inks and paper are studied routinely. The examination of questioned documents has come to the attention of the public in such famous cases as the Hauptmann case and more recently the Hiss case. In our own area, an armed robber was proven to have written thirteen notes with which he demanded money from cashiers in as many robberies.

Just a casual inspection of the working of the Crime Laboratory will lead one to say "I had no idea they did so many things." Such a comment is often heard since the popular conception of scientific policework is influenced by radio, television, novels, and the "comic" strips. The Pittsburgh and Allegheny County Crime Laboratory, although still in a state of development, is continuously striving to provide the maximum in service to the policeman. This goal relates to quality of service as well as to the nature and quantity of service. For the entire field of scientific crime detection, properly called "criminalistics," the need for technical progress of all kinds seems clear. First, academic facilities for training workers, administrators, and educators in the field must be more fully developed. Second, more research, both pure and applied, must be conducted by competent workers and administrators. Lastly, a greater understanding on the part of the police of the proper place of the crime laboratory in policework will result in the most efficient use of the available facilities.

In the relatively new field of criminalistics one can foresee scientific progress making the "things" involved in crimes more and more important in their solution. ●

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Health Careers

(Continued from Page 42)

The National Association of Secondary-School Principals and the National Vocational Guidance Association formed committees of educators to help advise the project officers. The associate art director of *Life* magazine designed the book and selected the illustrations. Six picture stories include photographs contributed by *Life*. Teachers and pupils in thirty schools cooperated in an informal pre-testing of the book.

In its final form, the *Guidebook* extends to approximately 150 pages. Printed in two colors, it is illustrated throughout with line drawings in addition to the photographs. The first fourth of the book discusses the meaning of a career in health—its opportunities, its satisfactions, its settings, the teamwork it implies, the question of training costs. Then comes a special Health Careers Calendar—a picture chart showing the time required for education or special training for seventy-six representative health occupations.

Finally, there are the actual briefings, which describe in detail 156 major occupations in the health field. Some of these are familiar to everyone as health careers—the medical professions, veterinary medicine, nursing, pharmacy and the like. Others, equally essential but perhaps less well-known as health careers, include such fields as basic sciences related to health, industrial hygiene, medical technology, psychology, sanitary engineering, and public health statistics.

Each briefing discusses what the job is, why it is interesting and important, who is likely to make good in it, how to get started, where this kind of work fits into the health partnership, the advantages and disadvantages of the occupation, typical earnings, opportunities for specialization and advancement, and other basic facts.

Every effort has been made to offer high school students a realistic picture of the possibilities open to them in the health field. Career opportunities exist for young women as well as young men, for top-flight students as well as those with "C" averages, for the person who wants a job immediately after high school as well as the youngster willing to spend an additional four to ten or more years on his education and training. The idea is to help the 7 million high school students in our country realize the variety of health service possibilities—in technical and supporting occupations in addition to the professions.

Teachers and vocational counselors will be able to use the *Guidebook* as they talk to students about ways of putting individual talents and skills to work, and the students themselves can consult it at a time when they have reached the first, and perhaps most important, educational crossroad of their lives.

Along with the *Guidebook*, a smaller book is being published mainly for community use. Under the title, *Partners for Health*, it includes much of the material found in the beginning chapters of the *Guidebook*—the story of health careers and their partnerships.

As a way of rounding out Operation Health Career Horizons, various visual aids are being planned to reach the community after the *Guidebook* has been distributed to schools. These include leaflets addressed to students and their parents, and posters for school and community use.

The National Health Council feels that the publication of *Health Careers Guidebook* marks the first step in acquainting communities and students alike with the opportunities and rewards of a major career field. And it is the Council's hope that the book will prove of special interest to principals and counselors, as well as to teachers of high school science. Such men and women often give a youngster his first glimpse of the world where science is more than a subject—where knowledge gained in the laboratory and classroom can have real meaning in one of the most needed areas of the world's work. ●

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Elementary Mathematics

(Continued from Page 47)

"minus times minus is plus," teacher "B" suggested to "A" to "clinch the proof" by the well-established relationship:

$$r_1 (\cos \theta_1 + i \sin \theta_1) \cdot r_2 (\cos \theta_2 + i \sin \theta_2) = r_1 r_2 [\cos(\theta_1 + \theta_2) + i \sin(\theta_1 + \theta_2)].$$

Since for negative numbers $\theta_1 = \theta_2 = 180°$, it's like falling off a log to show that $-r_1 \cdot -r_2 = + r_1 r_2$.

4. Illustrations, verbal or concrete, must either enrich the meaning of a principle or a process or show the application of a principle or a process or, as further inductive evidence, strengthen the belief in, or respect for, a principle or a process. Whatever its function the illustration must be completely within the ken and experience of the pupil. The illustration *must* make sense to the pupil: viz, despite the popularity of movies, radio, and TV, there are still many common experiences of city children that are not at all common to rural children, and vice versa.

5. Exercises, especially verbally dressed-up exercises, must make sense to the pupils (it goes without saying they must make sense to the teacher). To provide a practical exercise for the D = ST (Distance-Speed-Time relationship), we find "problems" such as this: Johnny and his father went on a trip. The first day they traveled at an average speed of 30 miles per hour for eight hours. How many miles did they cover that day?" Sooner or later even the less than bright children wake up to the hoax played on them!

6. Beware of newly acquired words, which merely postpone the need for understanding, and actually act as a sort of opiate. A teacher fresh from a survey course in Mathematics was asked by one of her pupils: "Miss X, what's the largest number?" Lightning fast, Miss X replied: "Infinity." In an interval of time that seemed to Miss X "infinitesimal," the pupil countered with: "How about infinity and one, infinity and two, . . . ?"

7. A teacher must understand a principle or a process from his vantage point (more or less advanced) *and* from that of the pupil. The latter is often intrinsically more difficult, more trying, more discouraging, and as every experienced teacher knows, the most effective for teaching pupils to understand. For the sake of our pupils and ourselves let us remember that big knowledge grows from little knowledge; that a little knowledge is a dangerous thing *only* when the possessor of a little knowledge does not know that it is a little knowledge. If it were not so, all of us would be "in danger." ●

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Preserving Documents

(Continued from Page 49)

paper by pressure exerted by a steam-heated hydraulic press.

The process is interesting to watch. The operator lays the document on a sheet of the plastic (which resembles cellophane) on a steel plate. He carefully fastens all loose fragments to the plastic sheet with a colorless plastic glue.

The prepared document is then covered with another sheet of the cellophane-like material and another plate. A double thickness of ordinary blotting paper is placed on the plate and the sandwich-within-a-sandwich, consisting of the two steel plates with the plastic-encased document, is placed on top.

Several additional double sandwiches, separated by blotters, make a multi-layer assembly which is placed in a steam-heated press. The blotters compensate for any inequalities in the paper and assure uniform pressure.

The heat and pressure soften the cellophane sheets and the plastic is forced into the fibers of the paper, making the finished document look like a very shiny piece of paper.

The excess foil is trimmed from the edges of each document and the document is indexed and filed in storage boxes. The boxes are stored in dust-proof and air-conditioned rooms.

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To make the records available, many have been microfilmed. Of others you can get a photostat at cost of reproduction.

Thus the historical records or the information in them is made available to scholars and students, yet the records themselves are preserved for future generations. ●

★ ★ ★ ★ ★

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J. C. Warner
President, Carnegie Institute of Technology

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Science is on the Way *Out!*

(Continued from Page 46)

feet, in reverse order. The white oak and beech leaves, last to have fallen, make up the top layer, and are in a good state of preservation. Next comes the sugar maple, partly decomposed, and finally we see the crumbs which once were the leaves of ash and red maple. In handling these latter fragments, we can feel how they have become mixed with grittier particles of soil, enriching and giving a sponge-like quality to the soil. In reaching the bare soil, we have seen an illustration of the formation of one of its most vital parts—the humus.

While we look at these lower layers of the leaf litter, we see tiny animals scurrying around, and we recognize another lesson which could center about their mode of existence, and the tiny climates in which they live shielded from the sun and wind. But the lesson would be incomplete if left at this point, for the picture of interrelationships goes much further. Fifth graders can well appreciate what might happen to the soil as rain beat down on an unprotected slope. On the leaf carpet, however, each leaf acts as an umbrella and a shield, on which the bullet-like raindrops bounce and shatter. Then these bits of moisture, having lost their harmful force, trickle gently in among the lower layers, and soak slowly into the soil. Were it not for the protective cover of leaves, for the decaying action of the tiny animal and plant life, and for the spongy nature of the humus in the soil, such a slope would merely serve as a gutter, down which rainwater would rush, carrying valuable topsoil with it and endangering other parts of the landscape at its lower outlet. Need we say more?

There are scores of field trip possibilities within the reach of any elementary school teacher. It does, however, take time and imagination to plan the most effective routes and times of year for these field experiences. Some schools have recognized this limitation, and have developed their own field trip manuals, often with the aid of the secondary school science teachers. This written guide usually contains an annotated listing of routes to follow, including the approximate time for walking each distance, special requirements for equipment, what is visible along the route and at stops, and a simple map containing all the listed locations. Where used, these manuals have been especially helpful to new teachers entering the system, and to other teachers who need just that little bit of assistance to get started on field studies.

The use of the outdoors is more than just an aid to science instruction,—it is a *way* of science teaching which demands the best a teacher has to offer. Elementary science is growing rapidly in its use of outdoor laboratories, and it would be well for all of us to recognize the quality and quantity of science which may be learned through the skillful use of our environmental resources. The increasing numbers of well-integrated elementary science programs which begin with a correlated series of meaningful outdoor experiences would make it appear that the "good old days" in science teaching are really just ahead of us. ●

★ ★ ★ ★ ★

The teacher needs not only to be sensitive to the perplexities of his students, but to anticipate them in the classroom. When the process of learning precipitates the student into a maelstrom of intellectual confusion, does not the instructor have an obligation to help the student think his way out? If the professor has found in his religious faith a perspective which gives meaning and a degree of coherence to his world-view, he has an obligation to tell the student about it. This is especially clear if the college has the expressed aim of helping the student attain a satisfactory philosophy of life.

Phillips P. Moulton
Simpson College

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Film Strip Design

(Continued from Page 51)

concept a relation to reality, a tie-in to experiences common to the life of the pupils. The section also examines the application of those non-ferrous metals which evidence the particular property in such a way as to be of commercial value. This procedure provides a mechanism to include all the non-ferrous metals while using aluminum as the principal illustration.

For example, in presenting the concept of melting point, the cartoon is followed by a picture of an aluminum foundry, showing molten aluminum (melting point indicated) being poured into molds of many shapes for many end-use applications. The value of low melting points and the impact of alloying non-ferrous metals are then illustrated with such items as solder, fuse metal, and type metal. Finally, the significance of very high melting point is depicted by a tungsten filament in an electric lamp.

Similarly, ductility is first symbolized and then related immediately to three basic industrial processes—drawing aluminum wire, extruding aluminum, and spinning; these in turn are related to products both familiar and important, such as airplane parts and storm windows. Finally, items like copper wire and silver conductivity-bars are shown in order to broaden the picture of the importance of ductility among non-ferrous metals. Note that in discussing ductility or any of the other properties, it was deemed unnecessary and even confusing to show on any one frame the comparative values of *all* non-ferrous metals. Rather, only ones having commercial importance were included. Even here exceptions were made deliberately, both in the interest of strip length and to provide a basis for inquiry and discussion.

After reviewing the properties of the non-ferrous metals in pure or alloy forms, the strip introduces the drastic changes which occur when chemical compounds are formed, and ends with an orientation to the behavior of non-ferrous metals by means of an examination of their position on the periodic table.

The first strip will be about fifty frames long. As may be observed from its form, as described above, the plan is ultimately to produce a strip elaborating each property and relating the property to other phases of the science course covered before and after the unit on non-ferrous metals. The hope is that the "family of strips" eventually will find repetitive use throughout the science program, and that they will not only relate to one unit of the syllabus but will actually help in integrating the whole science experience. As this article is written, the plan also includes a pre-testing period in a limited number of schools before final editing and release.

If the experiment described is successful, other studies of a similar nature should follow, Perhaps it would be feasible to construct an entire course in general science on materials and processes of American industry. There is much to learn about how industry and education can operate together with mutual benefit. In this regard, the experiment has been stimulating to all involved. The freedom of action here accorded the teachers should encourage educators to be less fearful of "propaganda" and to seek closer ties to business and industry. The understanding and sympathy expressed by the teachers for the contributions and the goals of industry should encourage every businessman. The project described in this article is, we hope, only a beginning. ●

★ ★ ★ ★ ★

Proteins and Nutrition

(Continued from Page 58)

the amino acid being tested was fed until there was a slight, but unmistakable positive balance. This amount represented the minimum requirement of the subject. This work was repeated with each amino acid in turn until minimum requirements were known for all the eight essential amino acids.

If we analyze a protein, then, and determine its amino acid content, and we know from Dr. Rose's work the minimum needs for amino acids, can't we tell from the analytical figures just how good a food a certain protein is?

That's right. We have new simple methods for analyzing for amino acids, too. Chemical analyses are now much quicker and cheaper than feeding experiments, so that we have a great deal more information now about the values of different proteins than we ever did before.

What proteins are good sources of the essential amino acids?

Unfortunately, only the expensive animal proteins—meat, milk, cheese and eggs are well endowed with essential amino acids. The cheaper plant proteins are either very low or completely lacking in some of the essential amino acids. Some bean proteins, especially those of the soy bean approach, but never reach the animal proteins in their essential amino acid value.

Is there any danger of people not getting enough essential amino acids?

Not people in this country, eating a normal diet. One study showed that even the lowest income group consumed the eight essentials in amounts which exceeded the recommended intakes by factors of 1.4 to 3. American authorities advocate about two and a half ounces of mixed proteins per day for an adult. Obviously anyone who eats an egg or two, drinks some milk, and has a fair serving of meat or fish a day is well provided with proteins.

What about vegetarians? Back in 1948 the vegetarian party even had a candidate for President. He wanted us to slaughter all food animals, and convert all grazing lands into farms to raise vegetables. Can a person remain healthy on a strict vegetarian diet?

I doubt whether a person could be an absolute vegetarian from early childhood. After all, even George Bernard Shaw used to take liver pills. An adult, however, can stay perfectly healthy on a vegetable diet.

Different vegetable and cereal proteins lack different essential amino acids, so the right sort of mixture can make up for the deficiencies of the individual proteins. If a vegetarian relaxes a little, and eats milk, cheese and eggs, he will probably have a better diet than the rest of us, because he pays more attention to it.

That's very well for this country, because we have a pretty high standard of living. What about the East, with its millions of people? How about the Indians with their bowl of rice? I understand that their yield in crops per acre is twice what we grow in this country, yet they are undernourished. Obviously they can't give us any of their crowded acres to grow meat animals. Is there any way that these people can get more first class protein?

I've been talking about biochemists most of the time, but it took the organic chemists and the chemical engineers to solve this problem. You will remember what happened to Dr. Rose's graduate students when just one amino acid was missing. They couldn't use the rest of the amino acids in the diet. Cereal proteins are like that—they are usually deficient in the amino acids lysine and methionine. We used to immobilize jeeps by taking the distributor rotor out. With that in your pocket the jeep just wouldn't run, even with gas in the tank. Just so, adding lysine and methionine to the cereal proteins make them completely available to the body.

The organic chemists and the chemical engineers figured out a way to make these amino acids cheaply in large quantities. The Army is thinking about adding them to the bread it feeds the troops. A ton of wheat needs only about 20 pounds of lysine and methionine to be a complete protein. So there is hope that small quantities of synthetic amino acids will make large quantities of good proteins available to this hungry planet.

There is, of course, a great deal more to nutrition than proteins and essential amino acids. Man needs some twenty different vitamins, for example, and behind each of these vitamins is an equally fascinating history of its discovery. Just as much time could be devoted to man's needs for minerals, and his energy requirements. The biochemist studies the chemistry of life, and his field is as broad as life itself.

ANNOUNCER—Thank you, Dr. Wooster and Mr. Nair. To get a copy of the pamphlet, "Facts About Foods," send a post card to "Chemistry and You," care of Station WCAE, Pittsburgh 19, Pa. A copy of "Facts About Foods" will be sent to you absolutely free. "Chemistry and You," is a weekly presentation of the Pittsburgh Section of the American Chemical Society. ●

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Basic liberal education does not look upon students as future professors or specialists in all the branches of knowledge and the liberal arts taught in the curriculum. It does not look upon them as future gentlemen or members of the privileged class. It looks upon them as future citizens, who must act as free men and who are able to make sound and independent judgments in new and changing situations, either with respect to the body politic or to their own particular task.

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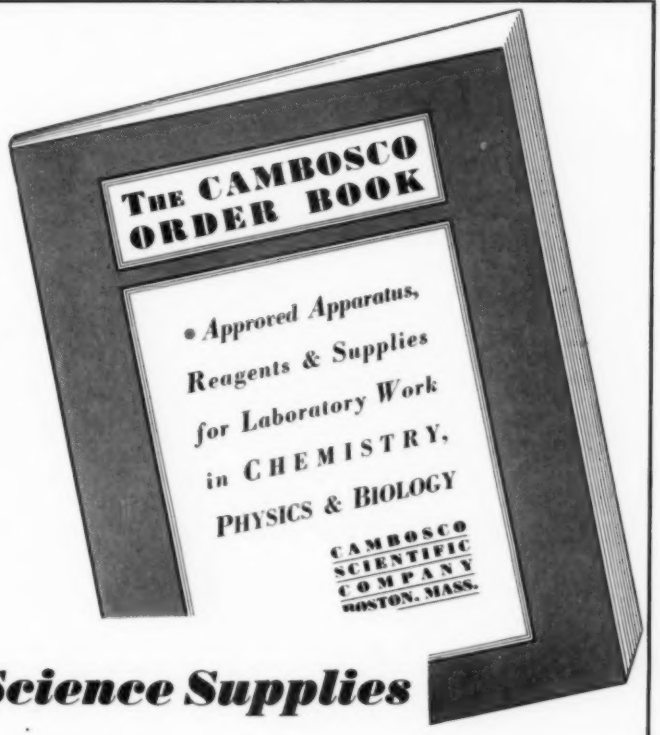
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